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Aeronautics Education, Research, and Industry Alliance (AERIAL) Year 2 Report and Year 3 Proposal

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Aeronautics Education, Research, and Industry Alliance (AERIAL) Year 2 Report

The Aeronautics Education, Research, and Industry Alliance (AERIAL): a comprehensive, multi-faceted NASA EPSCoR 2000 initiative, contributes to the strategic research and technology priorities of NASA while intensifying Nebraska's rapidly growing aeronautics research and development endeavors. AERIAL enables Nebraska researchers to: (a) continue strengthening their collaborative relationships with NASA Field Centers, Codes, and Enterprises; (b) increase the capacity of higher education throughout Nebraska to invigorate and expand aeronautics research; and (c) expedite the development of aeronautics-related research infrastructure and industry in the state. This report contains a summary of AERIAL's activities and accomplishments during the second year of implementation.

I. Core Funding for Research Infrastructure Development

Nebraska utilizes core funding to broaden AERIAL's impact beyond the individual parameters of the three collaborative research team (CRT) components. Core funding is utilized for two purposes: (a) to foster the initiation of new contacts with NASA Field Centers and Enterprises and to support the collaborative relationships between Nebraska and NASA researchers in areas outside of the three research components; and (b) to build additional human and information infrastructure that will ensure the sustained growth of the state's aeronautics research and industry after NASA funding ends.

AERIAL is housed in the Division of Aeronautics and Transportation Policy and Research facilities at the University of Nebraska at Omaha's Aviation Institute. It utilizes the existing NASA Nebraska EPSCoR management structure – a structure that has a proven track record of success with NASA and a demonstrated commitment to aeronautics and space science. This structure is well suited to manage AERIAL's goals and objectives, the varied interests of AERIAL stakeholders, and the statewide emphasis of its mission.

Dr. Brent Bowen, the Director of the Nebraska Space Grant Consortium and the Aviation Institute, continues as the NASA Nebraska EPSCoR Program Director for AERIAL. **Mr. Scott Vlasek** oversees development and ongoing maintenance of the AERIAL website and the creation of information technology and software for support of the outreach aims of AERIAL. **Dr. Henry Lehrer** leads the newly created Native Institute for Managing Applications in Geospatial Extension (IMAGE), which now oversees the projects and objectives of the successful Nebraska Native American Outreach Program. Dr. Bowen maintains frequent contact with the staff and researchers via individual and team meetings and e-mail. The principal investigator (PI) for each collaborative research team is directly accountable to Dr. Bowen for the implementation and progress of AERIAL-related activities. The PIs are responsible for monitoring the progress of each segment of their research team and holding monthly team meetings with their CRT participants.

Additionally, a new position was incorporated into the AERIAL staff. **Mrs. Karisa Vlasek** was selected as the first NSGC & EPSCoR Geospatial Extension and Research Specialist. Vlasek coordinates the transfer of geospatial technologies throughout Nebraska via the newly established Nebraska Geospatial Extension Program. This position provides technology transfer and commercialization of geospatial data and systems. Additionally, the liaison function of this position supports and strengthens collaboration with Nebraska's Land-Grant extension service and the UNL Center for Advanced Land Management Information

Technologies (CALMIT), while establishing geospatial learning centers at community and tribal colleges. The NSGC's relationships with business incubators and technology parks will also be cultivated through this position's daily activities. Maximizing workforce development, developing geospatial programs, and engaging the higher education community and citizen users in geospatial science are among this position's principal duties.

Mrs. Jocelyn Nickerson continues as the NSGC & EPSCoR Research Implementation and Communications Specialist. Although this position provides support to the NASA Nebraska Space Grant Consortium, most of the responsibility is focused primarily on EPSCoR. This position is the key staffer that supports the three CRTs, educational outreach, and technology transfer through project management and external communications. Symposia development, grant proposal writing, and aeronautics and space education outreach are among this position's principal duties. Additionally, the liaison function of this new branch helps ensure that funded researchers' projects see fruition and strengthens the relationship between the NSGC & EPSCoR office and the aviation community.

Leverage of Additional Funding

During Year 2, the AERIAL leadership team pursued grants through five additional funding opportunities, four of which were awarded. These proposals were submitted to the National Science Foundation (NSF), the Aerospace State Association, and the National NASA Space Grant organization. The first, titled "Nebraska EPSCoR Infrastructure Improvement Grant," was awarded from NSF and allocated \$9,124 for the development of a research partnership between Nebraska EPSCoR and Nebraska's tribal colleges. Through this grant, AERIAL personnel were able to develop and present a comprehensive "Grant Writing Workshop" for members of Little Priest Tribal College, Nebraska Indian Community College, Nebraska Native American Public School Systems, and other members of Nebraska's Native American population.

The second grant, the only grant not funded, was pursued through the Opportunities for Enhancing Diversity in the Geosciences NSF grant and was titled "Geoscience Education Opportunities on the Winnebago Indian Reservation." This \$300,000 grant would have assisted in the expansion and development of the Native Institute for Managing Applications in Geospatial Extension (IMAGE). Native IMAGE leaders continue to pursue additional funding opportunities to assist in achieving the goals they have set for their organization.

The third grant, awarded through the Aerospace States Association's Mathematics, Science and Technology Education (MSTE) grants, was titled "Families United (FUN) in the Discovery of Mathematics, Science, and Technology: Systemic Initiative to Improve MSTE Skills of Nebraska's Native American Youth." This grant provided \$29,000 to AERIAL researchers who work directly with teachers in Nebraska's Native American educational systems. This MSTE grant was originally awarded during NIRIAD, however AERIAL researchers directed the grant's initiatives to fruition.

The final two grants were successfully obtained through the NASA Space Grant Designated Upgrade (\$218,750) and Workforce Development grant (\$82,500). These grants provide collaboration between AERIAL and the NSGC. Additional funding pursued during Year 2 totaled \$656,874, with \$339,374 successfully awarded.

II. Student Support/Workforce Development

The likelihood that Nebraska will sustain long-term growth in aeronautics research and industry is dependent on the ongoing development of a well-trained aerospace workforce.

Nebraska recognizes that it must continue enhancing its internal capacity both to motivate its youth to pursue education and careers in aerospace-related fields and eventually to encourage them to seek related employment in the state. While the NSGC continues to be the primary source of aerospace-related outreach activities for the state, AERIAL includes the provision of CRT-based outreach activities as well as fellowships, assistantships, and internships for undergraduate and graduate students.

The Implementation Team was created to support the workforce development component of the program, which also provides an opportunity for those on this team to cultivate their own abilities for career enhancement. Additionally, Karisa Vlasek, in her role as the NSGC & EPSCoR Geospatial Extension Specialist, works closely with geospatial industry personnel from CALMIT and the Earth Resources Observation System (EROS) Data Center in Sioux Falls, South Dakota. This collaboration provides the opportunity for the placement of students in work-study and internship programs to assist those students in gaining much needed work experience. Additionally, substantial portions of three graduate assistantships for Basel El-Kasaby, Nanette Metz, and Patrick O'Neil are also devoted to the SATS effort. Such focused research allows for these participants to become experts in the SATS study.

III. Quality Assurance and Program Evaluation

The NASA Nebraska EPSCoR management team is utilizing its data management system in the implementation of NASA-funded projects. All components of AERIAL have undergone intensive self- and external evaluation. Consistent with NASA EPSCoR guidelines, NASA Nebraska EPSCoR has begun to address the following evaluation components. Each CRT has begun to experience research success through the development of their programs. Numerous publications and presentations have resulted from current CRT research.

Technology transfer is occurring between AERIAL staff and researchers and the University of Nebraska Technology Park through continued contact with Ms. Celika Caldwell, Interim Director of Technology Transfer, and Mr. Stephen Frayser, President. An internship program at the Technology Park for UNO aviation students is currently being implemented. AERIAL personnel continually monitor possibilities for transfer of technology to Nebraska's aviation industry.

Each CRT continues to build collaboration between their team and researchers from specific NASA Field Centers. Dr. Scott Tarry executes regular meetings of UNO SATS researchers and support staff and maintains regular contact with SATS officials at LaRC. Such officials include the UNO SATS Technical Monitor, Bruce Holmes, and the NASA SATS Program Manager, Jerry Hefner. Additionally, contact is routinely maintained between Dr. George Gogos, CEFD CRT leader, and Dr. Vedha Nayagam from the National Center for Microgravity Research at the John Glenn Research Center at Lewis Field, OH. This collaboration included information exchange as well as the simulation of Center research. The CEFD numerical model will be validated using experimental data obtained by Dr. Nayagam. Dr. Ram Narayanan, ARS CRT leader, maintains routine contact with the ARS technical monitor, Dr. K. John Ranson, from Goddard Space Flight Center in Greenbelt, MD.

The NASA Nebraska EPSCoR program continues to pursue collaborative aerospace research activities through the AERIAL-sponsored research on spaceports. This area provides research assistance to NASA's program for privatizing spaceport operations, maintains relationships with NASA's Kennedy Space Center (KSC), and outlines research activity for following years. Dr. Bowen and the AERIAL/Space Grant Technical Advisory Committee

(TAC) continue to review all program evaluations and reports. Recommendations for ensuing years are recorded and modifications are made as necessary.

The principal investigators from each CRT have proven their scientific accomplishments and demonstrated communication of those accomplishments through the following:

- Scientific publications,
- Presentations at academic conferences and symposia,
- Increased collaboration with NASA and other researchers in the state, and
- Proposal submissions to other funding sources.

Evaluations will continue to focus on these outcomes, which considered prior to future awards. Junior faculty recipients of fellowships and seed and travel grants continue to submit reports detailing scientific accomplishment, ensuing academic publications/ presentations, and proposal submissions. Recipients of seed grants submit similar semi-annual progress reports.

In November 2002, Mr. Scott Vlasek, NASA Nebraska Space Grant & EPSCoR Manager of Technology-Based Educational Systems, traveled to the Association for Continuing Higher Education (ACHE) Conference in Birmingham, Alabama. He accepted the Distinguished Credit Award for the NASA Nebraska Space Grant & EPSCoR-supported aviation undergraduate distance education program, an education outreach component he supervises. While attending the ACHE conference, Vlasek, in collaboration with Denny Acheson of the UNO Aviation Institute; and Melba Acheson, Larry Winkler, and Karen Garver, of the UNO College of Continuing Studies, presented research titled "Success with an On-Line Degree Completion Program: Teamwork within an Institution."

As the AERIAL staff and researchers complete their second year of work, they look forward to achieving long-term systemic growth in Nebraska's aerospace research and industry. Such development will be evident long after NASA funding ceases. Progress toward this end has already begun through the cultivation of innovative research and collaborations. Continued success of the AERIAL CRTs is anticipated through increased levels of refereed publications, invited presentations, and development of patents. Second year successes bring the expectation of continued development and collaborations. The CRTs will continue to receive support and encouragement from AERIAL leaders in their effort to provide long-lasting, impacting services for the aviation industry. Increases in non-NASA forms of aerospace research funding will also continue to be promoted through AERIAL outreach efforts. Efforts made through Native IMAGE and the statewide scholarship program are direct outcomes of AERIAL staff engaging in education outreach initiatives. These include activities geared to increase the number of Nebraskan students enrolling in aerospace-related fields of study at Nebraska's colleges and universities and efforts to increase the number of Nebraskan college graduates accepting faculty and researcher positions within the state.

IV. Funds Distribution and Financial Management Systems and Controls.

As with the collaborative research teams, the distribution of all funding occurs on a competitive basis. Calls for proposals are issued statewide through a variety of channels, and proposals are accepted from researchers at any Nebraska institution. Selection is made by ad-hoc committees drawn from the TAC and Nebraska EPSCoR Board.

The Aviation Institute at the University of Nebraska at Omaha (UNO) houses and acts as the managing structure for AERIAL, and thus maintains overall control and responsibility for its implementation. All participating AERIAL institutions form subcontractual agreements with UNO, which use standard grants and contracts and financial accounting procedures that are

subject to internal as well as external audits. Dr. Bowen is responsible for the day-to-day fiscal management of AERIAL, while UNO's Office of Grants Accounting prepares regular fiscal reports. Dr. Bowen approves all project expenditures, subject to further approvals and reviews, as specified in university procedures.

V. Schedule of Joint Meetings with NASA Personnel

A key component of Nebraska's strategy in initiating, broadening, and sustaining its relationships with NASA personnel has been its emphasis on face-to-face, on-site meetings with personnel from NASA Field Centers and Strategic Enterprise Offices at NASA Headquarters. The NASA Nebraska/AERIAL director, as well as other AERIAL staff, continues this strategy by meeting at least once each year with NASA EPSCoR personnel at NASA Headquarters and University Affairs Officers at collaborating NASA Field Centers. These meetings are timed to occur after the completion of progress reports but before TAC meetings. This assures that NASA feedback on AERIAL performance is addressed during TAC meetings. Additional contact with NASA Center personnel is documented in Attachment 1.

Key personnel from the three CRTs have made at least one visit per year to collaborating Field Centers. Additional meetings are scheduled at academic conferences or symposia where Nebraska and their respective NASA collaborators are in attendance. NASA researchers are invited to make site visits to Nebraska to meet with AERIAL administrators and/or CRT faculty researchers and students.

In a continuing effort to strengthen AERIAL ties to national NASA personnel, each AERIAL collaborative research team, as well as the Native IMAGE seed research program, participated in the first-ever National NASA EPSCoR Conference in Washington, DC, in March 2003. CRT and seed research leaders highlighted their innovative research through poster presentations. Additionally, Dr. Brent Bowen hosted a panel session on working with NASA Centers at this conference.

VI. Program Administration

The administration of AERIAL continues to focus on the achievement of the program's goals and objectives, including ongoing identification of collaborative research opportunities with NASA personnel, the support of AERIAL's research endeavors, the building of Nebraska's aerospace infrastructure facility technology transfer, the implementation of outreach activities, and increased inclusion of Native Americans in all program activities. The AERIAL strategic planning process is ongoing as well and is reviewed at the semi-annual meetings of the TAC.

VII. Core Funding for Seed Research

A. Geospatial Extension

The Nebraska Geospatial Extension Program is part of a dynamic, new national initiative inspired by NASA. By a partnership between NASA with the United States Department of Agriculture (USDA), the visionary goal of placing a Geospatial Extension Specialist in each state has been achieved. The program is designed to help educate and train potential users of geospatial technologies, such as geographic information systems (GIS), remote sensing, and the global positioning system (GPS). In 2002, the NASA Nebraska Space Grant Consortium (NSGC) and EPSCoR program joined this national initiative, placing an emphasis on implementation at Native American reservations across the state.

The establishment of the Native Institute for Managing Applications in Geospatial Extension (IMAGE) on the Little Priest Tribal College (LPTC) campus provides the opportunity for increased collaboration between the college and the Nebraska Geospatial Extension Program at UNO. The Nebraska Geospatial Extension Program provides guidance to Native IMAGE personnel in their delivery of extensive geospatial data to those at LPTC and within the Winnebago community. The Nebraska Geospatial Extension Program also assists in the coordination of specialized geospatial workshops and training program focusing on GIS, remote sensing, and GPS. Such workshops and programs were developed and delivered in 2002 and 2003 through the University of Nebraska at Lincoln's CALMIT (Center for Advanced Land Management Information Technologies) and the United States Geological Survey's Earth Resources Observation Systems Data Center. Representatives from LPTC, Winnebago Public Schools, Nebraska Indian Community College (NICC), Santee Sioux Public Schools, Winnebago Extension, and the Winnebago Tribal Planning Department have participated in these training seminars. Workshop attendees were introduced to the concepts and applications of GIS, remote sensing, and GPS. Future workshops are in development and will be conducted in summer 2003.

The Nebraska Geospatial Extension Program also guides Native IMAGE personnel in the development of methods to supply the Winnebago community with geospatial information regarding well mapping, land-use, and grazing management. Nebraska Geospatial Extension Program personnel support Native IMAGE staff members in the organization of enhancement of LPTC's traditional and on-line courses.

The first-ever Geospatial Demonstration Project in Nebraska was completed in 2002 to expose members of the Santee Sioux community in Santee, NE to various geospatial data. The project consisted of three components: (1) Teacher and Faculty Training, (2) a Student Workshop, and (3) a Geoscience Fair and Community Forum. Teacher and faculty training commenced in June 2002 through a workshop conducted at CALMIT's training center in Lincoln, NE. Workshop attendees included teachers from Santee Public Schools and faculty from NICC, LPTC, and the University of Nebraska at Omaha (UNO). Instructors from Santee and NICC then conducted an eight-week-long student workshop in July 2002 on the Santee reservation. Selected Santee high school and NICC college students were given GPS receivers and were trained how to collect geospatial data. Students researched specific projects related to the reservation. In October 2002, a Geoscience Fair and Community Forum were conducted at Santee Public School. Students who participated in the summer workshop showcased their projects and gave presentations. Those in attendance included parents and grandparents of the students as well as members of the Santee community and Tribal Council. Following the presentations, the audience was provided over fifty color infrared images taken of the Santee reservation in July 2002. These images were acquired through a partnership with the ARS CRT. The images initiated audience comments on environmental issues affecting the reservation. This Geospatial Demonstration Project method of exposing the community to geospatial applications will be exported to other Native American Reservations.

The Nebraska Geospatial Extension Program also collaborated on the production of 1,000 DataSlate CDs for distribution and use across the United States. DataSlate is an award-winning software product specifically designed for teachers by the NASA Jet Propulsion Laboratory (JPL) with assistance from UNO and the University of Nebraska at Lincoln (UNL). The product is a former recipient of NASA's Space Act Award and has recently been approved for full distribution by NASA and JPL through UNO. The software allows users to easily navigate

through large imagery data sets and to overlay and examine two data sets simultaneously. Teachers participating in NASA-sponsored workshops have adopted this tool and have used it to develop new classroom activities using space data. The DataSlate CD was created after careful review of teacher classroom needs and was closely advised by UNO and UNL educators working with development engineers at JPL. DataSlate is targeted for the K-12 educational community.

The Nebraska Geospatial Extension Program supported a collaborative effort between Omaha Public Schools and the Office of Internet Studies in the College of Education at UNO. International Space Station (ISS) EarthKAM is a NASA-sponsored educational project that allows students from across the globe to take pictures of earth from space. Students access the ISS EarthKAM webpage and control a digital camera mounted on the ISS. Photographs are taken based upon student input as the ISS orbits at 380 kilometers above the earth. The program is designed to motivate and excite students about science. Teachers use the images to teach lessons in physics, technology, geography, math, earth science, biology, art, history, and cultural studies.

Members of the Nebraska Geospatial Extension Program are involved in several geospatial professional societies, including the Nebraska GIS/LIS Association, Nebraska GIS Steering Committee, Nebraska I-Team, Intertribal GIS Council, Association of American Geographers, and the American Society of Photogrammetry and Remote Sensing. To date, the team has attended and presented at numerous conferences and workshops leading to the development of a network of geospatial expertise.

Numerous geospatial collaborations have been established with the following NASA Centers: Stennis Space Center, Goddard Space Flight Center, Johnson Space Center, Ames Research Center, Jet Propulsion Laboratory, and Dryden Flight Research Center. Collaboration is also maintained with the UNO School of Public Administration through Dr. Sam Brown, who is conducting an evaluation of Native IMAGE education outreach components.

A website was created to convey information about the program to the public. The website includes press releases, white papers, remote sensing imagery, research outcomes, pictures from geospatial events, and an extensive list of website links. Members of the Nebraska Geospatial Extension Program were engaged in many opportunities for professional development. Training and conference opportunities pursued by Nebraska Geospatial Extension Program personnel are listed below.

Nebraska Geospatial Extension Program Research Outcomes

Vlasek, K. (2003, June). *Nebraska's geospatial extension program*. Paper to be presented at the Nebraska GIS/LIS Omaha User's Group Meeting, Omaha, NE.

Vlasek, K. (2003, May). *Nebraska's geospatial program*. Paper to be presented at the 2003 Nebraska GIS Symposium, Lincoln, NE.

Vlasek, K., Nickerson, J., & Schaaf, M. (2003, May). *Grant writing for the GIS professional*. Short course developed and to be delivered at the 2003 Nebraska GIS Symposium, Lincoln, NE.

- Lehrer, H., & Vlasek, K. (2003, April). *Native American geospatial outreach*. Paper presented at the University of Redlands and Environmental Research Systems Institute, Redlands, CA.
- Vlasek, K., & Lehrer, H. (2003, April). Native IMAGE (Institute for Managing Applications in Geospatial Extension) [Abstract]. *Proceedings of the Nebraska Academy of Sciences*, 33.
- Vlasek, K., & Lehrer, H. (2003, April). *Native IMAGE (Institute for Managing Applications in Geospatial Extension): A Nebraska geospatial extension initiative*. Poster presented at the Nebraska Academy of Sciences Annual Meeting, Lincoln, NE.
- Bowen, B., Lehrer, H., Brown, S., Nickerson, J., & Vlasek, K. (2003, March). *Native IMAGE (Institute for Managing Applications in Geospatial Extension): A Nebraska Geospatial Extension Initiative*. Paper presented at the NASA EPSCoR Director's Meeting, Washington, D.C.
- Bowen, B., Lehrer, H., Brown, S., Nickerson, J., & Vlasek, K. (2003, March). *Native IMAGE (Institute for Managing Applications in Geospatial Extension): A Nebraska Geospatial Extension Initiative*. Poster presented at the NASA EPSCoR Director's Meeting, Washington, D.C.
- Vlasek, K., Bowen, B., & Schaaf, M. (2002, December). *Nebraska's geospatial extension program*. Paper presented at the NASA Nebraska Space Grant and EPSCoR Technical Advisory Committee Meeting, Lincoln, NE.
- Lehrer, H., & Vlasek, K. (2002, October). *Santee Sioux geospatial demonstration project*. Project presented at Santee Geospatial Science Night, Santee, NE.
- Vlasek, K. (2002, October). *Integrating science and Native American culture*. Poster presentation at the National Council of Space Grant Directors Fall Meeting, Dorado, Puerto Rico.
- Vlasek, K., Bowen, B., & Schaaf, M. (2002, October). *Nebraska's geospatial extension program*. Paper presented at the National Council of Space Grant Directors Fall Meeting, Dorado, Puerto Rico.
- Lehrer, H., Vlasek, K., Nickerson, J., & Bowen, B. (2002, October). *Geoscience education opportunities on the Winnebago Indian reservation (GEOWIRE)*. Proposal to the National Science Foundation, \$900,000. Not Funded.
- Lehrer, H., Nickerson, J., & Vlasek, K. (2002, October). *Santee Sioux Family Geospatial Science Night*. Workshop developed and delivered on the Santee Sioux Reservation, Santee, NE.

Nebraska Geospatial Extension Program Training, Workshops, and Conference Participation

ASPRS Annual Conference, Anchorage, AK, 2003
 Professional Airborne Digital Mapping Systems, Short Course
 Remote Sensing of GIS Wetlands, Short Course
 Nebraska GIS Symposium, Lincoln, NE, 2003
 Remote Sensing: An Overview of the State of the Art, Short Course
 GIS in Local Government, Short Course
 Nebraska Geospatial Extension Program, Display Booth
 Nebraska Academy of Sciences, Lincoln, NE, 2003
 Nebraska Space Grant & EPSCoR Technical Advisory Committee Meeting, Lincoln, NE
 2002- 2003
 NASA Ames Visit and Briefing, Moffett Field, CA, 2003
 ESRI Visit and Briefing, Redlands, CA, 2003
 Remote Sensing Workshop, EROS Data Center/South Dakota State University, Sioux
 Falls, SD, 2003
 Precision Agriculture Workshop, Lincoln, NE, 2003
 NASA Stennis Space Center Visit and Briefing, MS, 2002
 GIScience Conference, Boulder, CO, 2002
 Grant Writing Seminar, Omaha, NE, 2002
 National Council of Space Grant Directors Fall Meeting, Dorado, Puerto Rico, 2002
 Preparing Students for Careers in Remote Sensing, Durham, NH, 2002
 NASA-Sponsored Earth Grant Meeting, Storrs, CT, 2002
 NASA Nebraska Space Grant & EPSCoR collaboration building meeting with Little
 Priest Tribal College President and Staff regarding GEOWIRE NSF proposal
 development, 2002
 Nebraska GIS/LIS Meetings and Forums, NE, 2002-2003
 Nebraska GIS/LIS Omaha User's Group Meetings, Omaha, NE, 2002-2003
 Nebraska GIS Steering Committee Meetings, Lincoln, NE, 2002-2003
 Nebraska GIS I-Team Meetings, Lincoln, NE 2002-2003
 National GIS Day Activities, Omaha, NE, 2002
 ESRI, Introduction to ArcGIS I, San Antonio, TX, 2002
 ESRI Introduction to ArcGIS Survey Analyst, Live Web Training Seminar, 2003
 ESRI, Working with ArcPad Web Tutorial, 2003
 ESRI, Partnering for Community Action, Web Tutorial, 2003
 University of NE at Lincoln-CALMIT, Introduction to ArcExplorer and ArcView, 2002
 Research Systems Institute, Exploring ENVI, Boulder, CO, 2003
 Introduction to MultiSpec, EROS Data Center, Sioux Falls, SD, 2003
 Canadian Centre for Remote Sensing, Fundamentals of Remote Sensing, Web Tutorial,
 2003

B. Native IMAGE (Institute for Managing Applications in Geospatial Extension)

In January 2003, a center of excellence was established at Little Priest Tribal College though support from the NASA Nebraska Space Grant Consortium and EPSCoR programs. This

center is known as Native IMAGE (Institute for Managing Applications of Geospatial Extension). Native IMAGE provides extensive Winnebago geospatial data and information for those at LPTC and within the community to utilize for both educational and commercial purposes. Of the 35 current tribal colleges, few are pursuing a geospatial emphasis. Native IMAGE highlights the Winnebago community's involvement in the geosciences and fosters collaboration among the community, LPTC, and faculty participants from other tribal colleges, including Nebraska Indian Community College, Salish Kootenai College, and Sinte Gleska University, among others.

Organizationally, Native IMAGE is led by Dr. Henry (Hank) R. Lehrer, Director, and includes Rhonda Pitt – LPTC/USDA Extension, and Jan Bingen – LPTC Computer Science Department Director. The USDA collaboration will be cultivated through the newly established partnership between Native IMAGE personnel and Land Grant staff at the University of Nebraska – Lincoln. This partnership, which initiated the creation of a Geospatial Extension office at the University of Nebraska at Omaha, will strengthen the education outreach efforts of Native IMAGE.

Additionally, the first Native IMAGE student assistant was hired in March 2003 to help support institute activities while gaining invaluable experience. Other institute associates include LPTC faculty, staff, and consultant trainers. Several community associates and other support personnel, particularly from the University of Nebraska at Omaha (UNO) and the Center for Advanced Land Management Information Technologies (CALMIT) in Lincoln, NE, round out the initial staffing for the organization. The formation of a local community oversight committee is in progress as well as the establishment of an LPTC Geospatial Technical Advisory Committee board representing local and state academic, scientific, agricultural, and governmental officials.

The creation of Native IMAGE at LPTC has fostered numerous collaborations. The Winnebago Tribal Council has offered its full support to Native IMAGE, while the tribe's planning, construction, and environmental departments have expressed a strong desire to work with Native IMAGE. The Winnebago Water Quality Specialist requested an aerial photograph of a feedlot near the reservation, while the Winnebago GIS/GPS Specialist asked for an overflight photograph of the village to import into his GIS program. These data requests were honored with help of the Airborne Remote Sensing (ARS) CRT and the Nebraska Geospatial Extension Program, which gave color infrared images to the Winnebago Environmental Protection Department. A partnership between the Environmental Systems Research Institute (ESRI) and Native IMAGE was recently established. ESRI has agreed to donate geospatial-related books and materials to assist in expanding the holdings of the LPTC library. Additionally, Native IMAGE is working closely with the USDA-funded Winnebago extension agent, who will now partner with Native IMAGE on educational outreach projects. Planning and development of these geospatial educational activities has begun through the assistance of the Nebraska Geospatial Extension Program.

Native IMAGE provides training on Geographic Information Systems (GIS) and Airborne Remote Sensing (ARS) components and offers research opportunities in the other geospatial fields. Additionally, this new organization develops techniques to supply the community with resources such as information on water shed analysis, well mapping, land-use (pasture and agricultural), and precision farming. Native IMAGE supports several outreach endeavors that will expose the community to these new technologies.

Past NSGC & EPSCoR Native American outreach initiatives, launched through the Nebraska Native American Outreach Program (NNAOP), are now integrated into the current Native IMAGE agenda. Development of strong linkages and a viable partnership with the Winnebago Public Schools (WPS) is of high priority. Of particular emphasis is the extension of the highly successful Family Aeronautical Science (FAS) program to include geospatial activities focused on junior high and high school students. FAS was incorporated 3 years ago into the Santee Public School curriculum and continues to thrive. Similar programs have been implemented in Walthill and Winnebago, NE. The basic premise of the program, centered in grades five and six, continues to be Families United (FUN) in the Discovery of Science. The program continues to use the original format of prayer, dinner, and aeronautical activities. Each quarterly FAS night attracts as many as 120 students, parents, and extended family members. All participants have experienced the fun of jointly completing an aeronautical project such as airplane and rocket construction followed by flight demonstrations with the vehicle.

Additionally, the collaboration established through the FAS program led to the provision of interactive, high-speed internet service within Santee Public Schools. This allows Santee teachers to utilize the national NASA website to incorporate programs such as ISS EarthKam; Space Link; and Express Lessons and Online Resources into their curriculum.

NNAOP researchers, in collaboration with Nebraska EPSCoR, provided a grant writing Workshop for teachers from Macy, Santee, Winnebago, and Walthill Public Schools; faculty from LPTC and NICC; and members of Nebraska's Native American population. The event was held at the Marina Inn in South Sioux City, NE on Saturday, November 2, 2002. Participants were provided with grant writing materials and interactive lectures to assist them in seeking and applying for federal, state, and private grant funding.

The development of a bridge program in mathematics, science, and technology will soon be a cornerstone of the relationship between Native IMAGE and WPS. A literature review. Along with Winnebago community focus groups, determined that greater emphasis on a seamless mathematics and science program extending from the lower elementary grades to the tribal college is of critical importance. LPTC and Native IMAGE, in cooperation with WPS, will develop such a program.

The formative and summative evaluation of past activities is underway and Dr. Sam Brown, professor in the UNO School of Public Administration, is gathering qualitative and quantitative data from past FAS students, parents, and faculty. Using a series of interviews as the primary data-gathering instrument, an analysis of the exact impact of the first 2-3 years of FAS will be evaluated. This report should be available within the next several months.

C. Spaceports

Spaceports Seed Research Project at UNO completed their the second year of investigation in 2002. In the first year, Dr. Richard Box, principal investigator, with the assistance of Patrick O'Neil, doctoral research assistant, established connections with Kennedy Space Center (KSC), the Advanced Spaceport Technology Working Group (ASTWG), and state space programs while identifying interesting areas for further research. Also in this second year, the UNO spaceports team was expanded with the addition of Dr. Kenneth Kriz and Dr. Carol Ebdon, both of whom are professors in the UNO School of Public Administration.

The entire UNO spaceports team is intricately involved with the ASTWG process. Specifically, Box continues to participate in the ASTWG Commerce and Business Development sub-group through NASA teleconferences. Additionally, all UNO spaceports team members

attended the ASTWG sponsored Spaceports and Range Technology Conference held in Colorado Springs, CO in October 2002. Through collaboration in ASTWG, it has become clear that market analysis for space launch commercialization should be a significant element in UNO's research effort. Such analytical information continues to be of interest to federal and state agencies and private corporations. The UNO research team will continue to address areas of knowledge associated with the commercialization of space. These areas will be the focus of team members Ebdon and O'Neil, with assistance from Box.

Collaborations are maintained with the National Coalition of Spaceport States, the Oklahoma Spaceport Authority, Marshall Space Flight Center Systems Engineering and Integration, State of Alabama Aerospace Development Center, and the Office of the Space Architect at NASA Headquarters. Specific collaborations through KSC include Cristina Guidi, Advanced Concepts Manager; Joel Wells, Government Relations; Gregg Buckingham, University Affairs Officer; and L. Michael Freeman, Spaceport Technology Research Liaison. Additionally, the UNO spaceports program's collaborative effort was expanded with the placement of Steven Ryberg, a UNO graduate of UNO's master in public administration program, as an intern at KSC in the spring 2003 semester.

To establish new collaborations, Kriz traveled to meetings in Washington, DC and Huntsville, Alabama to work with transportation researchers and the National Coalition of Spaceport States. During the year, Kriz reviewed existing space market studies and wrote a technical paper on forecasting demand for space access; this paper will serve as the basis of next year's work in this area. In fall 2002, Kriz interviewed contacts regarding demand forecasting that has taken place and reviewed existing studies on demand for space launch. In spring 2003, he formulated a model of demand for commercial space transportation.

Box's work with the Office of Space Commercialization, Department of Commerce, and the State of Alabama aerospace personnel resulted in a proposal for the creation of the Space Commerce Research Council (SCRC). The SCRC is a spin-off from the work of the KSC Commerce and Business Development sub-group. Additionally, Box continued conceptual development of the education outreach component of the UNO spaceports team.

Through discussions with KSC staff early in the year, the spaceports project expanded into two different projects. The first creates a cost-benefit framework for use by KSC staff in submitting project-funding proposals to NASA headquarters, and the second is to assess, through a survey instrument, the progress of the stakeholder participation process that is part of the KSC commercialization of space launch initiative. This will create an information management and evaluation system. Box and Ebdon traveled to KSC in October 2002 to meet with NASA staff to formalize plans for Year 2 research. Ebdon concentrated on the cost-benefit project, while Box worked with KSC staff in creating an e-mail survey instrument. This survey was mailed to approximately 200 members of the Advanced Range Technology Working Group and the ASTWG. Patrick O'Neil compiled a summary of the responses, which was submitted to KSC. The responses tended to be much more heavily focused on range issues than overall space commercialization issues.

Evaluation mechanisms are in place for the UNO spaceports project. First, a market study is being completed through a paper documenting the theoretical demand for commercial space transportation and review of existing demand forecasting. The final product will be a report consisting of the theoretical model and an assessment of the current state of demand forecasting. Additionally, an assessment of participation process is being conducted to provide a final product to KSC staff on the results of the survey of ASTWG/ARTWG participants.

Spaceports Team Research Outcomes

O'Neil, P., Box, R., Bowen, B., Kriz, K., & Ebdon, C. (2003, April). A model for collaborative research with the Kennedy Space Center (KSC) supporting spaceport development and commercialization [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 25.

O'Neil, P., Box, R., & Bowen, B. (2003, March 6-8). Spaceport development: A new transportation infrastructure challenge. *Proceedings of the 44th Annual Transportation Research Forum, George Washington University*.

Box, R., Bowen, B., & O'Neil, P. (2002, October). The Nebraska spaceport research program. *Paper presented at the National Space Grant Conference, San Juan, Puerto Rico*.

Box, R., Bowen, B., & O'Neil, P. (2002, March). NASA Spaceport Research: Opportunities for Space Grant and EPSCoR Involvement. *Paper presented at the National Space Grant Aerospace Technology Symposium 2002*.

VIII. Support for NASA Collaboration Building

A. Travel Grants

Through AERIAL, grants are available for travel to NASA research and field centers in support of specific collaboration-building activities. AERIAL gives priority to faculty members who are not members of the three collaborative research teams but wish to pursue new NASA collaborations. Several types of travel grants are awarded: (a) day visits; (b) short-term (three to four days) visits; (c) one- to two- week visits; and (d) 10-week internships. Travel grants are awarded to faculty members to travel to other academic institutions for possible NASA collaboration. AERIAL also awards travel grants for faculty researchers to attend academic conferences, symposia, and/or technical meetings that offer opportunities for the development of new networks and linkages with NASA-affiliated researchers as well as joint presentations and the strengthening of existing collaborations. Todd Bonkiewicz, graduate fellow, and Pat O'Neil, doctoral fellow, traveled to Washington, DC in March 2003 to participate in the Transportation Research Forum Conference. Additionally, Dr. Dan Pope, CEFD CRT researcher, traveled to Chicago in March 2003 for the 3rd Joint Meeting of the U.S. Sections of the Combustion Institute. Travel grants have also fostered collaborative relationships at the Johnson Space Center, Dryden Flight Research Center, Stennis Space Center, Kennedy Space Center, and Ames Research Center.

B. Technical Advisory Committee

The Technical Advisory Committee (TAC) convenes biannually and is directly involved in guiding grant funding and initiatives as well as providing advice and recommendations to Dr. Bowen. Members are informed of progress through periodic written reports and oral presentations from Dr. Bowen and the research cluster principal investigators, evaluation results and reports, and the AERIAL on-line newsletter. The TAC also participates in AERIAL's strategic planning process through in-depth interviews, board meetings, and review of draft documents; its members also act as liaisons between AERIAL and the organizations they

represent. For a complete listing of the TAC Members, please see Attachment 2. The committee is composed of key administrators from Nebraska industry, Nebraska government, Nebraska Space Grant, Nebraska EPSCoR, and the aviation community and academia. They bring to the board ample resources and knowledge that advance the goals of AERIAL. The configuration of the TAC is designed to ensure that productive relationships between AERIAL and Nebraska's state capability programs are cultivated and sustained.

The TAC is composed of one or two campus coordinators from each academic affiliate, representatives from government and industry, and the management team of the AERIAL program. This committee boasts a diverse group of both males and females representing African American, European, Asian, Middle Eastern, and Native American cultures. The statewide network represented on this committee has prospered and become more cooperatively aggressive this year. Dr. Bowen is responsible for the implementation of policies developed by the committee, and ensures that these policies are carried out on each campus by both communicating with the Campus Coordinator and placing specific policy provisions within subcontracts. The three CRT principal investigators (Drs. Tarry, Narayanan, and Gogos) serve as ex-officio members on the TAC along with AERIAL Director Bowen and Space Grant Assistant Director Schaaf.

The 2002 Fall NSGC & EPSCoR Technical Advisory Committee (TAC) meeting was held on December 3, 2002, in Lincoln, Nebraska at the University of Nebraska Technology Park. Many prominent and talented members of industry and the academic world were present and enthusiastically joined the discussion. Dr. Brent Bowen provided the group with an overview of the TAC charge, membership, and annual report. Representatives from each collaborative research team and seed research area provided updates on their activities. The committee provided input on NSGC & EPSCoR activities and on the meeting's structure. Outcomes from this meeting will allow the NSGC & EPSCoR program to continue to strive for educational and research excellence.

The spring TAC meeting was held on Friday, April 25, 2003, in conjunction with the 123rd Nebraska Academy of Sciences at Nebraska Wesleyan College in Lincoln, NE. Many TAC members and university representatives were present. This meeting served as an opportunity for NASA Nebraska EPSCoR representatives to report on various outcomes resulting from current research endeavors. Each collaborative research team presented on their achievements thus far and answered questions posed by the committee. A summary of the AERIAL sponsored Native IMAGE accomplishments was also provided.

The spring TAC meeting provided the unique opportunity to review the NASA Nebraska EPSCoR AERIAL Year 2 Report and Year 3 Proposal. Additionally, emerging research areas in Geospatial Extension and Native IMAGE were presented along with NASA Nebraska EPSCoR's plans for technology transfer.

C. Coordination with Nebraska Space Grant Consortium

As director of the NSGC, Dr. Bowen provides written and oral AERIAL progress reports at meetings of that organization's board. As with the AERIAL TAC, NSGC affiliate members provide recommendations regarding AERIAL activities, progress, and modifications. The NSGC Board provides feedback during the annual AERIAL performance review. Dr. Bowen's dual role as NSGC director and AERIAL director ensures effective and efficient coordination and communication between the two organizations. This coordination is exemplified by the

proposed AERIAL strategies relating to Native American and student outreach, which dovetail (but not duplicate) existing educational outreach through the NSGC.

D. Coordination with State EPSCoR Committee and Other Stakeholder Organizations

Project Director Bowen makes regular progress reports to the Nebraska EPSCoR Committee. Members of the EPSCoR committee are asked to participate in annual external reviews of the research teams' performance and outcomes. Dr. Royce Ballinger's position as Director of Nebraska EPSCoR, as well as his membership on the TAC, aid in the coordination of AERIAL's activities with other Nebraska EPSCoR programs. Annual AERIAL reports are sent by the Nebraska EPSCoR office to the Nebraska Department of Economic Development and all members of the Nebraska Industrial Competitive Alliance, the State Aeronautics Board, the Nebraska Aviation Council, and the Nebraska Math and Science Initiative. AERIAL coordinates its activities with those of other federal agencies, including the DOD, NSF, FAA, and Department of Transportation through Drs. Bowen and Ballinger. All organizations affiliated with AERIAL are actively encouraged to utilize the NASA Nebraska/AERIAL website.

E. Electronic Resources

The NASA Nebraska EPSCoR/AERIAL management team utilizes extensive electronic resources – including a joint NASA Nebraska EPSCoR/AERIAL website, CD-ROM technology, and distance education – to bolster AERIAL's research and outreach endeavors, further the goals of AERIAL, and extend its impact throughout the state and nation. The existing NASA Nebraska Space Grant Consortium & EPSCoR website (<http://nasa.unomaha.edu>) includes grant announcements and applications, current research projects and listings of published research, program descriptions, program staff, and upcoming events. The website provides links to: NASA, NASA EPSCoR, NASA Enterprises and Centers, and the National Space Grant and Fellowship programs; numerous aerospace/aeronautics websites of interest to researchers, educators, students; and other NASA EPSCoR and Space Grant-funded sites.

CD-ROM technology is a key component of AERIAL's public education and industrial relations efforts. The AERIAL staff has developed a CD-ROM that highlights the articles chosen to be included in the publication of the Journal of Air Transportation. This distribution can also be found at <http://jat.unomaha.edu>.

F. Technology Transfer/Industrial Relations

NASA Nebraska EPSCoR is committed to the identification and development of technology transfer opportunities. The technology transfer phase of the research project transforms the designs, ideas, research, and innovations of Nebraska researchers to the development phase, where the project is nurtured by identified technology transfer experts (eventually leading to utilization applications). The team has identified many organizations and individuals to contact for assistance in the technology transfer phase. At a minimum, the team has identified an individual at each NASA Center where research collaborators are located as well as national, regional, and state technology transfer organizations to contact for expertise. A representative from the Nebraska Department of Economic Development serves on the NASA Nebraska AERIAL TAC, as do representatives from the University of Nebraska Technology Transfer Center and the University of Nebraska Technology Park.

NASA Nebraska EPSCoR seeks assistance in the areas of technology-based problem solving, marketing, commercialization services, and enabling initiatives from the NASA Regional Mid-Continent Technology Transfer Center. The Nebraska affiliate of this organization, Director Thomas Spilker of the Nebraska Industrial Competitiveness Services at UN-L, is also a resource to draw upon. As in the past, NASA Nebraska AERIAL personnel continue to work with Marianne Clarke from the Great Lakes Industrial Technology Center. Another national resource is the Robert C. Byrd National Technology Transfer Center in Wheeling, West Virginia, headed by President Joseph P. Allen.

Additionally, each of the three collaborative research teams have a technology transfer plan incorporated into their proposal to promote successful technology transfer for NASA EPSCoR. Private industry collaborators are invited to participate in the advisory board meetings, where they can provide guidance and input for the program's research activities.

G. Public Outreach Education and Extension

Outreach education and extension play a fundamental role in the AERIAL EPSCoR grant through the dissemination of information and enhancement of educational value. Outreach education and extension focus on three areas: (a) the use of the World Wide Web to post information; (b) collaboration through regional and national conferences in aeronautics and education; and (c) the enhancement of distance education capabilities and technologies. Three cornerstone projects are associated with AERIAL's outreach education and extension efforts. Each component – based on the research of the CRTs – encompasses collaboration with researchers and NASA personnel as well as interaction with extension agencies, dissemination of information, and involvement in the Native IMAGE-managed FAS program.

AERIAL Collaborative Research Teams

Among other current research endeavors, AERIAL supports three major Collaborative Research Teams (CRTs) whose nexus is a common focus in aeronautics research. While each CRT – Small Aircraft Transportation System (SATS), Airborne Remote Sensing for Agricultural Research and Commercialization Applications (ARS), and Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD) – has a distinct research agenda, all three contain similar strategies for intense NASA collaborations, junior faculty development, student assistantships, public outreach, and technology transfer. Research from each CRT results in transfer of technical information via the UNO Aviation Institute Monograph Series. This series is indexed in various databases such as Educational Resource Information Center (ERIC), Transportation Research Information Services (TRIS), Aviation TradeScan, NASA Scientific & Technical Reports (STAR), and the Online Computer Library Center (OCLC). Additionally, all CRTs have direct relevance to the state's economic development as well as near- and long-term potential for the aerospace industry. Each CRT's research progress is documented through the NASA Nebraska Space Grant & EPSCoR website at <http://nasa.unomaha.edu/sgep/epscor.htm>

IX. Small Aircraft Transportation System (SATS) CRT

The Small Aircraft Transportation System Collaborative Research Team (SATS CRT) has had another productive year during the second year of funding through NASA EPSCoR. The CRT has worked to develop and implement a research agenda to support SATS research activities at NASA's Langley Research Center. As in the past, the work conducted by the CRT, while clearly focused on SATS, is not confined to a single discipline or topical area. Research undertaken by CRT members includes policy analysis, business case development, systems engineering and decision support analysis, and financial analysis. In each case, the CRT is making progress towards its larger objective of conducting research that is both credible and useful to decision makers within and outside NASA. In addition to their own research projects, CRT members Dr. Scott Tarry and Dr. Massoum Moussavi have also played ongoing roles in the Transportation Systems Analysis and Assessment (TSAA) Working Group that is guiding systems research for NASA Langley SATS researchers and the National Consortium for Aviation Mobility (NCAM), which is the governing body for the public-private partnership established by Congress to lead the SATS initiative.

The narrative below provides details of the various projects undertaken by SATS CRT members during the last year. The CRT has made considerable progress on its EPSCoR-funded research agenda and has also had success in attracting non-EPSCoR funding for additional projects related to SATS. CRT members Tarry and Moussavi recently received word that a proposal for an additional \$100K worth of work has been approved by the TSAA and NCAM.

Scott Tarry continues his role as principal investigator. His work on SATS as an alternative to the Essential Air Service (EAS) program was featured in panels on transportation in remote and rural communities at the 2003 Annual Forum of the Transportation Research Forum and the 2003 Annual Meeting of the American Society for Public Administration. These conferences provided opportunities to engage scholars and policymakers unfamiliar with the SATS concept. In particular, Tarry's participation in the Air Transport in Remote Regions Forum, held in Cork, Ireland, gave him the opportunity to present his SATS research to a European audience. As a result of his work on SATS, Tarry has been invited to serve on the advisory board for a new Center on Air Transport in Remote Regions, which has been

established at Cranfield University in the United Kingdom. A manuscript focused on the SATS vs. EAS debate will be submitted for publication in June.

Tarry has also been involved in the drafting of a paper that conceptualizes the broader SATS vision. Written with Bruce Holmes, Associate Director of Airspace Systems at NASA Langley Research Center, the paper is scheduled for presentation at the AIAA-ICAS International Air & Space Symposium and Exposition in Dayton, Ohio in June 2003. The paper has also been invited for submission to the *Journal of Aircraft*. This work reflects the SATS CRT's ongoing involvement in the conceptualization of this important innovation in air transport.

Basel El-Kasaby, who serves as Tarry's doctoral research assistant, presented a paper that was co-authored by Tarry and Karisa Vlasek at the annual meeting of the Air Transport Research Society. This paper, which focused on insurance issues related to SATS implementation, was selected from the slate of conference papers for inclusion in a special issue of the *Journal of Air Transport Management*, where the paper is currently under review. El-Kasaby and Tarry have also been invited to submit a paper to a special issue of the *International Journal of Public Administration*. While not focused exclusively on SATS, the paper provides an opportunity to provide additional exposure for the SATS concept to general transportation and public policy audiences.

Massoum Moussavi leads the CRT's contribution to LaRC's ongoing effort to develop a computer-based decision support system model for SATS implementation. The primary focus of Moussavi's current work is the implementation of this model for managing SATS planning, design, and operation within the State of Nebraska. A direct outcome from these efforts was a Master's thesis by Moussavi's student, Jaime Vargas, who completed his MS in Civil Engineering in May 2002. Vargas continues to work on his Ph.D. dissertation with Moussavi on the SATS project. Other outcomes of Moussavi's work included three journal publications, four conference papers, two research reports, and two presentations on the Small Aircraft Transportation System.

Drs. Moussavi and Tarry continue to participate actively in NASA SATS Transportation Systems Analysis & Assessment Working Group (TSAA-WG) teleconferences and contribute to the transportation system assessment and analysis work conducted at LaRC. Moussavi is in regular contact with Stuart Cooke, Jr., who leads that effort for NASA's SATS TSAA-WG team. Moussavi has worked to coordinate the research conducted by other team members, so that the team's diverse research projects contribute to the decision support model development efforts in Nebraska and at the national level.

Dr. John Bartle continued his work on economic and financial issues related to SATS implementation. His work has led to three published papers and two in progress. One paper applies a microeconomic model to SATS to anticipate barriers to deployment. The other paper applies concepts from "new institutional economics" within a context of a federal system to address the question of the long-term sustainability of infrastructure. In both cases, Bartle attempts to present to industry audiences powerful social science models that speak to the larger questions regarding SATS. In a third paper related to SATS, Bartle examines the issue of procurement processes in state government. He writes that much of what SATS portends to achieve in rural regions, state governments will be integral to the program's success. A better understanding of how state governments procure goods and services is an important step in understanding how this important stakeholder may or may not be able to accommodate SATS.

Bartle has two “works in progress” on similar issues and targeted for similar forums. The first project focuses on airport finance, in particular local airport authority sources of revenue in the current system with suggestions for improving the financial incentives. The second project is likely to result in a book chapter with a broader focus on all modes of transportation, which is targeted to a more general audience.

In an effort to achieve one of EPSCoR’s larger goals – attracting external research support – Bartle has submitted a grant proposal to broaden the scale of his previous efforts in the area of transportation finance and to solidify the efforts of the School of Public Administration to be a leader in this area of study. His objective is to improve contacts with organizations involved either as funders or producers of research on this issue. These include federal agencies, foundations, professional groups, state governments, and other universities. The long-term goal is to attract financial support congruent with SATS CRT interests and capabilities in transportation finance, leading to research that can improve the resource allocation of transportation infrastructure.

Dr. Brent Bowen continued his involvement in the SATS CRT by overseeing research related to general aviation security. This research, completed with graduate fellow Todd Bonkiewicz, continues to investigate the changes that are being seen in transportation security policies and requirements and the affect those changes will have on the effective implementation of SATS. Bowen also supervised the research of doctoral student Nanette Scarpellini-Metz, who continues her investigation into the lessons that can be learned from NASA’s Advanced General Aviation Transport Experiments (AGATE), the predecessor to SATS. Both areas of research have been presented at academic conferences and refereed papers have been submitted.

The researchers at UNO contribute directly to the national SATS program, a component of the Aerospace Technology Enterprise through the NASA LaRC Vehicle Systems Technology Program. SATS CRT research responds to direct project development goals to “establish technical and non-technical objectives and prepare partnership processes for coordinated investments to advance both infrastructure and vehicle technologies” (NASA EPSCoR Research Compendium, 2003). Specifically, SATS CRT leaders are addressing the Aerospace Technology Enterprise Objective 7: Mission Affordability in Goal 2: Advancing Space Transportation by examining economic and financial issues related to the implementation of SATS. Additionally, the final envisioned implementation of SATS addresses future aerospace capability issues as outlined by the Final Report of the Commission on the Future of the United States Aerospace Industry, December 2002.

Public outreach and education has been an integral part of the CRT’s work during the first year as well. CRT members have presented SATS-related work to a number of different audiences around the nation and abroad. Year 2 has been productive for the SATS CRT. The team has produced a variety of papers and presentations related to the year’s work. A number of these have been or are in the process of being published in peer reviewed and popular publications. More important, however, is that the work completed in the second year provides a solid foundation for the CRT to meet the larger goals and objectives outlined in the original EPSCoR proposal. The team will continue to coordinate its efforts with NASA Langley researchers and other SATS researchers around the country.

Leverage of Additional Funding

During Year 2, SATS CRT leaders and investigators pursued funding beyond that which is provided by the AERIAL grant. Specifically, the SATS team applied for three separate grants offered by the Research Triangle Institute (RTI), which focused on planning, case studies, and

system development. The first grant, coordinated by Dr. Scott Tarry, was awarded by RTI for research titled "Small Aircraft Transportation Planning." This award provided an additional \$127,000 to support evaluation of Nebraska's current air transport system and infrastructure and the state's ability to accommodate SATS.

The second RTI grant, in the amount of \$37,000, was awarded for completion of a specific SATS CRT research project titled "SATS Business Case System Studies." This project currently complements AERIAL SATS research by evaluating various SATS business models in the context of Nebraska's transportation system.

Finally, RTI awarded the SATS CRT with an additional \$103,000 to complete a project titled "System Support Modeling and Business Case Development for SATS in Nebraska." This project will begin in June 2003 and focus on the development of a decision support model and SATS business case for Nebraska, including a statewide airport survey. In total, the SATS CRT secured an additional \$267,000 in research funding.

Technical Monitor Contact

Dr. Tarry continued to maintain consistent contact with the SATS CRT Technical Monitor, Dr. Bruce Holmes, at NASA LaRC. Tarry also established and developed the SATS CRT's relationship with LaRC through Jerry Hefner, who is now the SATS program lead, and Stuart Cooke, who is TSAA lead at LaRC and a primary liaison for the SATS CRT.

SATS CRT 2001 – 2003 Cumulative Outcomes

Bartle, J. (in press). Transportation infrastructure. *Handbook of Public Sector Economics*.

Bartle, J., & Korosec, R.L. (in print). A review of state procurement and contracting. *Journal of Public Procurement*, 3.

Bowen, B. & Scarpellini-Metz, N. (in print). AGATE outcomes analysis: Laying the foundation for SATS. *Journal of Aviation/Aerospace Education and Research*.

Bowen, B. & Scarpellini-Metz, N. (in review). A research case study: Exploring the influence of AGATE. *Public Works Management and Policy*.

Holmes, B., S.E. Tarry, & Durham, M. (in review). The Small Aircraft Transportation System (SATS) concept. *Journal of Aircraft*.

Moussavi, M., & Vargas, J., (in print). Small Aircraft Transportation System (SATS): Nebraska implementation. *Journal of Transportation Research Board*.

Moussavi, M., & Vargas, J., (in review). Planning and design of Small Aircraft Transportation System (SATS) in Nebraska. *ASCE Journal of Transportation Engineering*.

Tarry, S.E., Vlasek, K., & El-Kasaby, B. (in review). Aviation insurance and the implementation of the Small Aircraft Transportation System (SATS) [Special issue]. *Journal of Air Transport Management*.

- Bartle, J., & Swayze, R. (2003). *Reforming airport finance: Improving infrastructure investment*. Unpublished manuscript.
- Holmes, B., Tarry, S.E., & Durham, M. (2003, July). The Small Aircraft Transportation System (SATS) concept. Paper accepted for presentation at the AIAA-ICAS International Air & Space Symposium and Exposition, Dayton, Ohio.
- Bartle, J. (2003, April). The sustainable development of transportation infrastructure: An institutional perspective [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 27-28.
- Bonkiewicz, T., & Bowen, B. (2003, April). General Aviation Security Issues Impacting the Small Aircraft Transportation System in the Post 9-11 Environment [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 28.
- Metz, N., & Bowen, B. (2003, April). AGATE/SATS: A case study in federal program management. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 23.
- Moussavi, M. (2003, April). Decision support model for implementing Small Aircraft Transportation System (SATS) in Nebraska [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 27.
- Tarry, S.E., Vlasek, K., & El-Kasaby B. (2003, April). A comparison of the Small Aircraft Transportation System to existing transportation system options in Nebraska [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 27.
- Tarry, S.E., Vlasek, K., & El-Kasaby B. (2003, April). Aviation insurance and the implementation of the small aircraft transportation system [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 34.
- Tarry, S.E. (2003, April). *Alternatives to Essential Air Service (EAS) and public service obligation routes: Air transport in remote regions*. Paper presented at the 3rd Annual Forum on Air Transport in Remote Regions, Cork, Ireland.
- Bartle, J. (2003, March). *A two-sector economic model of technological progress in air transportation: Implications for public investment*. Poster session presented at the annual meeting of the NASA Experimental Program to Stimulate Competitive Research Program, Washington, DC.
- Moussavi, M., & Vargas, J., (2003, March). Small Aircraft Transportation System (SATS): Nebraska implementation. Paper presented at the 82nd Annual Meeting of Transportation Research Board, Washington, DC, 1-18.
- Tarry, S.E. (2003, March). Air transportation in rural communities. Paper presented at Annual Meeting of the American Society for Public Administration, Washington, DC.

- Tarry, S.E. (2003, March). *Policy options for rural America: Comparing the Small Aircraft Transportation System (SATS) and the Essential Air Service (EAS)*. Paper presented at the Annual Meeting of the American Society for Public Administration, Washington, DC.
- Tarry, S.E., Bartle, J., & Moussavi, M. (2003, March). *Small Aircraft Transportation System (SATS): Research collaborations with the NASA Langley Research Center*. Poster session presented at the annual meeting of the NASA Experimental Program to Stimulate Competitive Research Program, Washington, DC.
- Tarry, S.E., Bartle, J., & Moussavi, M. (2003, March). *Implementing SATS in Nebraska*. Paper presented at the annual meeting of the NASA Experimental Program to Stimulate Competitive Research Program, Washington, DC.
- Tarry, S.E., & Bonkiewicz, T. (2003, March). *Assessing the role of privately owned public use airports*. Paper presented at the Annual Forum of the Transportation Research Forum, Washington, DC.
- Nickerson, J., Moussavi, M., Smith, R., Tarry, S., & Bowen, B. (2002). *Innovatively saving the future of transportation: The Small Aircraft Transportation System (SATS)*. *Journal of Public Transportation*, 5(3), 67-82.
- Bonkiewicz, T., & Bowen, B. (2002, October). *Analytic assessment of general aviation security issues in the Post 9-11 environment: Implications for the Small Aircraft Transportation System (SATS)*. *Collegiate Aviation Review*, 20(1), 17-28.
- Tarry, S.E., & Moussavi, M. (2002, October, 29). *Implementing the Small Aircraft Transportation System (SATS) in Nebraska and the Great Plains states*. Paper presented to the Transportation Systems Analysis and Assessment Working Group, NASA Langley Research Center.
- Fink, M., Bowen, B., Tarry, S., et al. (2002, September). *The upper Great Plains Small Aircraft Transportation System (SATS) plan*. Paper presented at the Western Region NASA Space Grant Conference, Big Sky, MT.
- Moussavi, M. (2002, September). *NASA's Small Aircraft Transportation System (SATS)*. Presentation to the Missouri Valley Section of the Institute of Transportation Engineers (MOVITE) Annual Meeting, Omaha, NE.
- Moussavi, M. (2002, August). *A systems engineering approach for managing Small Aircraft Transportation System (SATS) planning, design, and operations*. Paper presented to the National Aeronautics and Space Administration (NASA), Hampton, VA.
- Bowen, B., & Metz, N. (2002, July). *Policy research, a case in agency transition: The NASA AGATE/SATS program*. *Proceedings of the Air Transport Research Society International Conference*. Seattle, WA.

- Tarry, S.E., Vlasek, K., & El-Kasaby, B. (2002, July). Aviation insurance and the development of advanced small aircraft. *Proceedings of the Air Transport Research Society International Conference*. Seattle, WA.
- Tarry, S.E., Moussavi, M., El-Kasaby, B., et al., (2002, June). Implementing the Small Aircraft Transportation System (SATS) in Nebraska. Research findings presented to North Carolina/Upper Great Plains SATS Lab.
- O'Neil, P., & Bowen, B. (2002, May). *Enabling technologies for the Small Aircraft Transportation System (SATS), an annotated bibliography*. (UNOAI Report 02-3). Omaha, NE: University of Nebraska at Omaha Aviation Institute.
- Bowen, B. (2002, April). *Collegiate aviation education: Opportunities through research, the SATS 101 example*. National Congress on Aerospace Education, Washington, D.C.
- Metz, N., & Bowen, B. (2002, April). Policy research results from a retrospective assessment of the NASA AGATE program: Implications for NASA SATS [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences, 22*.
- Tarry, S.E., El-Kasaby, B., & Vlasek, K. (2002, April). *New technologies and policy change: Advanced small aircraft and rural transport*. Paper presented at the Annual Meeting of the Midwest Political Science Association, Chicago, IL.
- Tarry, S.E., & El-Kasaby, B. (2002, April). Technology-based solutions for rural transportation: The Small Aircraft Transportation System (SATS) [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences, 22*.
- Tarry, S.E., & Vlasek, K. (2002, April). An examination of insurance issues surrounding the Small Aircraft Transportation System (SATS) [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences, 23*.
- Bowen, B. (2002, March). SATS research update, Aerospace Technology Working Group (ASTWG) session. *Research presented at the National Council of NASA Space Grant Directors Meeting, Washington, D.C.*
- Bowen, B. (2002, March). SATS research update, Aerospace Technology Symposium 2002. *Research presented at the National Council of NASA Space Grant Directors, Aerospace Technology Working Group, NASA White Sands Research Facility, NM.*
- Bowen, B., & Metz, N. (2001, October). The policy research construct: Applications to aviation and space research. [Abstract] *Research Roundtable, Fall Conference of the University Aviation Association*. Nashville, TN.
- Bowen, B., & Tarry, S.E. (2001, October) Identification of public policy perspectives in the deployment of the Small Aircraft Transportation System (SATS). *43rd Annual Proceedings of the Transportation Research Forum*, 1-8.

Bowen, B. & Tarry, S.E. (2001, October). *Identification of public policy research applications in the deployment of a new air transportation system component*. Paper presented at the Annual Meeting of the Transportation Research Forum, Williamsburg, VA.

Bowen, B. (2001, August). *Nebraska Small Aircraft Transportation System (SATS) work-plan update recommendations*. Paper presented at the SATS Leadership Team Meeting at NASA Langley Research Center, Hampton, VA.

Tarry, S., & Bowen, B. (2001, August). *The Nebraska work plan for SATS Research* [Abstract]. Presented at the meeting of the Research Triangle Institute SATS Forum. Raleigh, NC.

X. Airborne Remote Sensing (ARS) CRT

During 2002, the Airborne Remote Sensing (ARS) CRT research focused on four specific tasks: (1) airborne sensor integration and development, (2) sensor construction and testing, (3) new sensor development, and (4) theoretical modeling. Each task is described in detail below.

In a collaborative effort with the University of Nebraska – Lincoln Center for Advanced Land Management Information Technologies (CALMIT), the Year 1 full integration of airborne sensors and advanced remote sensing equipment aboard the CALMIT Piper Saratoga allowed this ARS CRT to commence airborne testing over Nebraska ground targets began soon thereafter. Additionally, the CALMIT Hyperspectral Airborne Monitoring Program (CHAMP) acquired data in support of 11 different research projects in 7 states, which provided necessary data to the ARS CRT.

In completion of the Year 2 proposed component “Airborne Remote Sensing Data Acquisition and Analysis,” research and analysis of various forests, prairies, fresh/salt water environments, and agricultural crops were achieved by the ARS CRT. Results based on analyses of initial datasets and early images acquired by AISA quantify the spatial variability of irrigated and dry land corn and soybean fields. In addition, the data has been used to estimate the normalized difference vegetation indices (NDVI) of different types of plots. The ARS CRT has also developed a technique to estimate leaf area index (LAI) remotely using reflectance in the green and red edge regions of the electromagnetic spectrum.

Additionally, in completion of the Year 2 proposed component “Development and Testing of New Sensors,” ARS sensor construction and testing involved the completed construction of the multiwavelength airborne polarimetric lidar (MAPL) system, which operates at 532 and 1064 nm wavelengths. ARS CRT personnel are currently performing preliminary field tests and calibration of the MAPL system, while integrating the equipment within the aircraft. This system employs a Nd:YAG laser which emits radiation at two wavelengths, the fundamental at 1064 nm and the frequency-doubled at 532 nm. Both laser beams are highly linearly polarized (100:1 extinction ratio) and have a beam divergence angle of 4 mrad. The receiver consists of four channels; two for each wavelength. Each wavelength contains one channel to measure co-polarized backscatter and one channel to measure cross-polarized backscatter. In addition to the polarimetric information that can be gathered, the lidar system also has ranging capability. The lidar system is capable of performing studies of vegetation canopy structure as well as characterization of vegetation depolarization. Characteristics of the MAPL system include lidar waveform capture and polarimetric measurement capabilities. Combining a vertical canopy structure model and the lidar range equation has resulted in a theoretical understanding of the vegetation canopy scattering. A single canopy vertical distribution is introduced along with a G-function to describe the effective leaf area index (LAI) in terms of the incident radiation direction. Three typical foliage area density functions were simulated representing different canopy shapes. Lidar waveforms from the three canopy models were obtained via simulations and compared with the NASA SLICER airborne lidar experiment data. Very good agreement between the simulated and experimental waveforms was observed, thereby validating the model. Ground signal-to-noise-ratio (SNR) under a single canopy condition is also being investigated by calculating the following noise factors: (1) signal-caused quantum noise, (2) background radiation noise, (3) dark current, and (4) thermal noise. System SNR values at green wavelength channels were computed to be more than 20 dB higher than those at near-infrared channels. Good SNR is obtained up to a range of 2000 m. Field

measurements at a range of 1500 m show that the system is able to probe canopy structure. The system has been packaged to fly aboard the research aircraft from a height of up to 1000 m.

Additionally, ARS CRT researchers have completed the breadboard development of the Synthetic Aperture Radar (SAR) system operating over the 9.8-10.2 GHz frequency band and are currently packaging the system to mount within the research aircraft. SAR is one of the main tools for microwave remote sensing because of its multi-dimensional high-resolution imaging capability and its ability to operate in nearly all weather conditions, day and night. The objectives of this project are to construct and deploy an imaging radar system using basic RF/microwave components for the remote sensing of underlying biophysical parameters (leaf area index, biomass content, etc.) aboard an airborne platform from heights up to 1,500 meters. The SAR system is an X-band, stepped-chirp FM, single polarization radar system. One of the unique features of the system is that the signal generation consists of a timing-controlled D/A converter and VCO arrangement to generate the stepped-chirp signal, thereby allowing for less design complexity and lower overall system cost. The individual block segments including waveform generation that transmit and receive hardware, antennas, quadrature detection, and image signal processing have been finalized and tested. The microwave system of the SAR has been designed and constructed and is currently under calibration and testing. Preliminary field tests have been conducted from a 10-meter high van-mounted boom on a variety of terrain types.

New sensor development was the ARS CRT's third initiative during Year 2. This task involves the further development of the laser fluorescence sensor, which ARS researchers believe will open up new opportunities for remote sensing of crop stress. Fluorescence is used in a wide variety of applications in remote sensing. Past applications of this technology looked at fluorescence signals at long integration times after the laser pulse interacted with the material producing the fluorescence. This CRT has characterized the fluorescence signal as a function of time after interaction with a frequency doubled Nd:YAG laser frequency doubled to the 532 nm interacting with chlorophyll in corn, soybeans, and trees. The emission spectra of chlorophyll from green leaves, taken at room temperature, show two maxima near 685 nm and 735 nm. In this new work, the temporal evolution of these spectra was observed as a function of time after the interaction of a 10-ns laser pulse. The time-dependent emission spectra were observed from 50 ns after the pulse to 250 ns. The emission spectra in the short time domain are 2-3 times the intensity emitted at 250 ns. The time-delayed emission spectra were compared for various amounts of plant stress from drought conditions. The new results indicate that the time dependent fluorescence spectra are superior to the long integration signal for indicating the degree of stress in the plant.

The final ARS CRT Year 2 task, theoretical modeling, involved further development of the ARS four-component microwave scattering models that are used to analyze scatterometer and SAR measurement data and retrieve target biophysical parameters, such as leaf area index, biomass, water content, soil moisture, etc. Theoretical simulation based on these microwave scattering models is conducted for scattering from corn canopies. The ARS CRT is also investigating the application of the method of moments (MoM) in leaf scattering. In this method, the equivalent surface electric current and magnetic current are solved through matrix equations, and the scattering cross sections are then evaluated using the known currents. MoM has several advantages for the computation of scattering problems from irregular and homogeneous dielectric objects and generally provides the most accurate numerically computed results. The widely used Rao-Wilton-Glisson (RWG) functions are used as basis functions in our MoM computations. In general, since the thickness of a leaf is very thin compared to the

wavelength, the impedance approach is used to solve the dielectric scattering problem. The scattering cross section of a leaf for different shapes and thickness is computed using the MoM method and will compare well with the results using the GRG and PO approximations.

This CRT has also investigated and evaluated four spectral estimation algorithms considered to be the most prominent and widely used methods in high resolution SAR imaging. These include Capon's minimum variance (Capon), amplitude and phase estimation (APES), adaptive sidelobe reduction (ASR), and spatially variant apodization (SVA) methods. Current simulations using X-band airborne SAR data acquired from Sandia National Laboratories show that Capon, APES, ASR, and SVA outperform the conventional Fourier method not only in terms of resolution, but also in amplitude bias. These results were deduced using images of rural terrain and will be useful in interpreting ARS CRT airborne SAR data when they become available in the future.

While the ARS CRT was largely successful in completing the second year's proposed tasks, and after careful deliberation and refocusing of ARS CRT goals and objectives, new sensor development and theoretical modeling were pursued in place of the Year 2 proposed components "Instrument Calibration and Validation" and "Error Characterization." Unforeseen delays in obtaining the necessary approvals for lidar mounting on the aircraft and in testing the SAR prevented the ARS CRT from completing these tasks. Therefore, as these approvals have now been acquired, "Instrument Calibration and Validation" and "Error Characterization" will be pursued as significant initiatives in Year 3.

NASA's Earth Science Enterprise is dedicated to understanding the total Earth system and the effects of natural and human-induced changes on the global environment. ARS researchers are responding to this mission component through specified data collection and the development of new, innovative sensors such as Synthetic Aperture Radar, which is a main tool for microwave remote sensing. This project assists in remote sensing of underlying biophysical parameters (leaf area index, biomass content, etc.) aboard an airborne platform and contributes to current agricultural and environmental needs.

The ARS team also contributes to the Earth Science application "Resources Management," which is concerned with balancing the resource demands and growth of populations with natural resource availability and sustainability. The data collected through the ARS CRT may be used to address specific environmental issues such as topsoil erosion, watershed management, wetlands mapping and management, and farmland loss.

Leverage of Additional Funding

ARS CRT leaders and investigators pursued a variety of additional funding opportunities during Year 2. The grants pursued by the ARS team are highly collaborative, involving various researchers and departments at the University of Nebraska – Lincoln (UNL). Dr. Don Rundquist, Dr. Anatoly Gitelson, and Dr. John Holz, ARS collaborators at UNL, are preparing a proposal for submission to the Environmental Protection Agency titled "Development and Implementation of a Comprehensive Lake and Reservoir Strategy for Nebraska as a Model for Agricultural Dominated Systems." The result of this proposal will be known in late 2003. The successful award of this grant would assist in ARS research involving remote sensing of water quality and would provide \$1.2 million over a three-year time period.

Another proposal, to be submitted in the near future is being prepared by Dr. John Schalles (Creighton University), Dr. Don Rundquist, and Dr. Anatoly Gitelson. This proposal will be submitted to the National Oceanic and Atmospheric Administration and would assist in the application of remote sensing in the measuring and monitoring of coral reefs, sea grasses, and

mangrove communities. This proposal, titled "Remote Sensing of Marine and Coastal Environments," would provide \$100,000 over two years. The results of this grant will be known in late 2004.

Dr. Runquist's third proposal, submitted in December 2002 and currently pending, was offered through the NASA Earth Science REASoN –(Research, Education and Applications Solutions Network) and is titled "Agroecosystem Analysis, Monitoring, and Modeling: A Solutions Network." This grant would complement ARS research regarding agriculture and rangeland remote sensing, and, if awarded, would provide approximately \$1,000,000 per year for five years of funding.

Additionally, a grant for "The Role of Remote Sensing in Integrated Pest Management" was recently submitted to the Vice Chancellor for Research at UNL for cluster seed research. This application was submitted by ARS Collaborator Dr. Thomas E. Hunt, with assistance from Dr. Gary Hein, Dr. Blair Siegfried, Dr. Don Rundquist, Dr. Albert Peters, Dr. Loren Giesler, Dr. John Watkins, and Dr. Stevan Qi Hu. If funded, this grant will allocate an additional \$100,000 over two years. In total, the ARS CRT has proposed and is applying for \$2.4 million in additional funding.

The ARS CRT is experiencing research success as it moves toward its third year of AERIAL funding. Such success is evident in the various papers and presentations resulting from the ARS team's work.

Technical Monitor Contact

Research and collaborative contacts are maintained between Dr. Narayanan and K. Jon Ranson, ARS CRT Technical Monitor, at the Biospheric Science Processing department at Goddard Space Center. Additionally, Dr. Don Rundquist maintains consistent contact with Ed Sheffner in the Office of Earth Science Applications Division at NASA Headquarters. Further research collaborations are maintained with the Commercial Remote Sensing Program at Stennis Space Center.

ARS CRT 2001 – 2003 Cumulative Outcomes

- Tan, S., & Narayanan, R. (in review). Design and performance of a Multiwavelength Airborne Polarimetric Lidar (MAPL) for vegetation remote sensing. *Applied Optics*.
- Rundquist, D., Perk, R., Leavitt, B., & Moon, J. (2003, May). *Applications of the AISA hyperspectral imager*. Paper to be presented at the 2003 Nebraska GIS Symposium.
- Rundquist, D. (2003, January). *CALMIT infrastructure and programs*. Paper invited for presentation at the United States Geological Survey's Earth Resources Observation Systems (EROS) Data Center, Sioux Falls, SD.
- Schalles, J., Rundquist, D., & Perk, R. (2003, January). *AISA flyover of the ACE basin, South Carolina*. Paper presented at the Annual Meeting of the National Oceanic & Atmospheric Association's Environmental Cooperative Science Center, Islamadora, FL.
- Alexander, D. & Thatipamula, C. (2003, April 25). Short time fluorescence from corn and soybeans plants [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 24.

- Bronson, B., & Moon, J. (2003, April 25). *Airborne remote sensing applications for agricultural and environmental studies*. Poster session presented at 123rd Meeting of the Nebraska Academy of Sciences, Lincoln, NE.
- Cantu, P. & Narayanan, R. (2003, April 25). Preliminary field testing of a Synthetic Aperture Radar (SAR) system for low altitude remote sensing [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 20.
- Corner, B. & Narayanan, R. (2003, April 25). A unified model for the information content of remote sensing imagery as applied to AVIRIS and LANDSAT TM data [Abstract], *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 21.
- Kim, S., Ji, S., & Palmer, R. (2003, April 25). High resolution spectral estimation for SAR imaging [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 24-25.
- Li, J. & Narayanan, R. (2003, April 25). Integrated spectral and spatial information mining in remote sensing images [Abstract], *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 21.
- Moon, J., Rundquist, D., Perk, R., & Leavitt, B. (2003, April 25). Remote sensing with the AISA hyperspectral imager [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 23.
- Pan, G., & Narayanan, R. (2003, April 25). Simulation of microwave scattering from a leaf using the moment method and comparison with analytical approximations [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 24.
- Tan, S., & Narayanan, R. (2003, April 25). Theoretical analysis of a multiwavelength airborne polarimetric lidar [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 20-21.
- Narayanan, R., Rundquist, D., Palmer, R., Alexander, D., & Larson, M. (2003, March). *Airborne Remote Sensing (ARS) for agricultural research and commercial applications*. Poster session presented at the annual meeting of the NASA Experimental Program to Stimulate Competitive Research Program, Washington, DC.
- Narayanan, R., Cantu, P., & Xu, X. (2002, June). An airborne low-cost SAR for remote sensing: Hardware design and development. *Proceedings of the 2002 International Geoscience and Remote Sensing Symposium, Toronto, Canada*, 2669-2671.
- Pan, G., & Narayanan, R. (2002, June). Comparison of microwave scattering models for leaf. *Proceedings of the 2002 International Geoscience and Remote Sensing Symposium, Toronto, Canada*, 653-655.

- Tan, S., & Narayanan, R. (2002, June). A multiwavelength airborne polarimetric lidar for vegetation remote sensing: Instrumentation and preliminary test results. *Proceedings of the 2002 International Geoscience and Remote Sensing Symposium, Toronto, Canada*, 2675-2677.
- Cantu, P., & Narayanan, R. (2002, April 26). Description of a synthetic aperture radar system for low altitude remote sensing [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences*, 20.
- Li, J., & Narayanan, R. (2002, April 26). Shape-based detection in remote sensing: Application towards information mining [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences*, 19.
- Pan, G., & Narayanan, R. (2002, April 26). Microwave scattering models for leaves and crop canopies [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences*, 19.
- Tan, S., & Narayanan, R. (2002, April 26). Description of a multiwavelength airborne polarimetric lidar for vegetation remote sensing [Abstract]. *Proceedings of the 122nd Meeting of the Nebraska Academy of Sciences*, 20.
- Bowen, B., Narayanan, R., et al. (2001, October). The Nebraska NASA EPSCoR Research Program in Airborne Remote Sensing. *Paper presented at the Western Region Space Grant Conference., Warm Springs Reservation, OR.*

XI. Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD) CRT

Considerable progress has been made by the Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD) CRT during 2002. The development of a transient axisymmetric numerical code has been completed. The code can be used to study droplet combustion within a convective environment [1, 2]. Results have been presented at two conferences [3, 4] and further results will be presented in additional conferences [5-8]. Additionally, two papers will be submitted for publication in archival journals during summer 2003. A graduate student completed his Master's degree in December 2002, and a new graduate student joined the research group in January 2003.

The NASA technical monitor of this project, Dr. Vedha Nayagam, leads an experimental research effort, a candidate for a flight experiment in the International Space Station, which is very closely related to the CEFD CRT numerical study. In January and March of this year, Dr. Nayagam's project underwent an internal (within NASA) and an external review. In both cases, since the CEFD CRT results are extremely relevant to Dr. Nayagam's effort, Dr. Nayagam connected through the internet to the CEFD website at UNL and presented some of the team's results during his presentation.

CEFD research conducted during 2002 addresses the difference in combustion behavior, given the same initial conditions, of an isolated liquid fuel droplet under two scenarios: moving droplet and suspended droplet combustion in a forced convection environment. The first problem simulates the injection of a droplet into a combustion chamber. In this case, the droplet is allowed to decelerate due to the drag force. The second scenario simulates the conditions that are typically present in experiments that employ the suspended droplet technique (constant velocity). The transient axisymmetric numerical model is used to simulate the two cases. The salient features of the model are briefly discussed and select results for n-heptane droplet combustion are presented below.

The problem considered is that of a single-component liquid fuel (n-heptane) droplet undergoing evaporation and combustion in a hot, convective, low pressure, zero-gravity environment of infinite expanse. For a moving droplet, the relative velocity (U_∞) between the droplet and freestream is subject to change due to the influence of the drag force on the droplet. For a suspended droplet, the relative velocity is kept constant.

The governing equations for the gas-phase and the liquid-phase consist of the unsteady, axisymmetric equations of mass, momentum, species (gas-phase only), and energy conservation. Interfacial conservation equations are employed to couple the two phases. Variable properties are used in the gas- and liquid-phase. Multicomponent diffusion in the gas-phase is accounted for by solving the Stefan-Maxwell equations for the species diffusion velocities. A one-step overall reaction is used to model the combustion.

The governing equations are discretized using the finite volume and SIMPLEC methods. A collocated grid is adopted. Hyperbolic tangent stretching functions are used to concentrate grid points near the fore and aft lines of symmetry and at the droplet surface in both the gas- and liquid-phase. The discretization equations are solved using the ADI method with the TDMA used on each line of the two alternating directions. Iterations are performed within each time-step until convergence is achieved. The grid spacing, size of the computational domain and time-step were tested to ensure that all solutions are independent of these parameters. A detailed discussion of the numerical model is given in [1,2].

The numerical model was used to investigate the combustion of a n-heptane droplet with

an initial diameter (d_0) of 500 μm . Two cases were studied: a) a moving droplet, and b) a suspended droplet within a convective environment. The results presented here are for an ambient temperature (T_∞) of 1000 K, an ambient pressure (P_∞) of 1 atm, an initial droplet temperature (T_0) of 297 K and initial Reynolds numbers (Re_0) of 8, 10 and 50.

Table 1 (below) compares the lifetimes of both moving and suspended n-heptane droplets for the Reynolds numbers considered. The table contains interesting results which need to be explained. For example, the lifetime of a moving droplet with $Re_0 = 50$ is longer than the lifetimes of moving droplets with initial Reynolds numbers of 8 and 10. Furthermore, for the same initial Reynolds number, the suspended droplet burns out faster than its moving droplet counterpart in two cases ($Re_0 = 8, 50$), while for $Re_0 = 10$, the result is opposite. The results presented in Table 1 are discussed in more detail below.

For $Re_0 = 8$, the suspended and moving droplet developed envelope flames at approximately the same time ($t = 30 \text{ ms}$). Considering the droplet lifetimes (231 and 240 ms), this happened at a very early stage. Once the envelope flame formed, it remained for both droplets until the end of their lifetimes. Thus during most of the droplet lifetime, both the suspended and the moving droplet experience the same flame configuration. This implies that the two droplets will exhibit similar burning behavior and thus similar lifetimes. The droplets in both cases have very similar diameter squared time histories.

Table 1: n-heptane droplet lifetimes for suspended and moving droplets.

$P_\infty = 1 \text{ atm}$ $T_\infty = 1000 \text{ K}$ $T_0 = 297 \text{ K}$ $d_0 = 0.5 \text{ mm}$	$Re_0 = 8$	Suspended	$t_d = 231 \text{ ms}$
		Moving	$t_d = 240 \text{ ms}$
	$Re_0 = 10$	Suspended	$t_d = 335 \text{ ms}$
		Moving	$t_d = 243 \text{ ms}$
	$Re_0 = 50$	Suspended	$t_d = 250 \text{ ms}$
		Moving	$t_d = 316 \text{ ms}$

Both Reynolds numbers (for the moving and the suspended droplet) decrease monotonically with time, however they decrease at different rates. The Reynolds number is defined as $Re = d(t)U_\infty(t)/\nu_\infty$, where $d(t)$ and $U_\infty(t)$ are the instantaneous droplet diameter and freestream velocity. The freestream velocity remains constant for the suspended droplet. As a result, the Reynolds number changes only with the droplet diameter. However, for the moving droplet, the droplet diameter decreases, and the droplet velocity decreases due to drag. Thus the Reynolds number for the moving droplet decreases faster than that for the suspended droplet.

The instantaneous Damköhler numbers for the two cases are discussed below. Here, the Damköhler number is defined as:

$$Da = \frac{R(t)}{U_\infty(t)} A \rho_\infty^{a+b-1} W_f^{1-a} \left(\frac{1}{W_o} \right)^b \exp \left(- \frac{E_a}{R_u T_\infty} \right)$$

W_o and W_f are molecular weights for the fuel and oxygen, and a , b , A , and E_a are constants. The Damköhler number is proportional to the ratio of droplet diameter to

instantaneous freestream velocity. This ratio is the characteristic convective time-scale. Thus, Da is proportional to $d(t)/U_\infty(t) = t_{conv}$. The Damköhler number for the suspended droplet decreases with time, while the moving droplet case increases slowly with time. The former result is expected since the suspended case, U_∞ is constant while the droplet diameter decreases. This results in a monotonic decrease in Da . For the moving droplet case, both $d(t)$ and $U_\infty(t)$ decrease. The resulting trend in the Damköhler number is not obvious. For $Re_0 = 8$, it seems that the droplet velocity decreases slightly faster than the droplet diameter.

For $Re_0 = 50$, both droplets ignite in the wake areas far downstream. After ignition, in the moving droplet case, the flame moves toward the droplet slowly and finally forms an envelope flame (at approximately $t = 270 \text{ ms}$) near the end of its lifetime. For the suspended droplet, no envelope flame is developed throughout its lifetime, and the wake flame remains at approximately the same location for most of the droplet's lifetime. At $t = 237 \text{ ms}$ the wake flame trailing the suspended droplet extinguishes. Thus, a pure evaporation process dominates in both cases. In the absence of envelope flames, the difference in Reynolds number histories between the two cases (Re is smaller for the moving droplet due to its deceleration) is the only cause for their different lifetimes shown in Table 1.

The combustion behavior for the two cases at $Re_0 = 10$ is quite different from the cases discussed above. Although the Reynolds number for the suspended droplet is again higher than that for the moving droplet throughout the droplet lifetime, the lifetime of the suspended droplet is approximately 40% longer than that of the moving droplet. The big difference in droplet lifetimes is caused by the difference in flame configurations. The moving droplet develops an envelope flame at an early stage ($t = 40 \text{ ms}$) of its lifetime. In contrast, the suspended droplet exhibits a transition flame (the flame partially surrounds the droplet) during most of the droplet lifetime. As a result, the front of the droplet is exposed to the ambient temperature, leading to a longer lifetime for the suspended droplet.

The results presented above for the three different Reynolds numbers seem to suggest that a moving droplet tends to develop an envelope flame at some stage during its lifetime, whereas a suspended droplet develops an envelope flame only at low initial Reynolds numbers. The flame configurations present in a burning droplet are a function not only of the Reynolds number, but of the Damköhler number as well. In the Damköhler-Reynolds number plane, regions with different flame configurations (envelope, transition and wake) were identified.

CEFD research is in direct correlation with the mission of NASA's Human Exploration and Development of Space (HEDS) Enterprise by employing "breakthrough technologies and ingenious designs" [9] and collaborating with individuals at John Glenn Research Centers (GRC) who are investigating related microgravity issues. CEFD may contribute to HEDS Life and Microgravity Sciences and Applications (LMSA) program goals "to increase human knowledge of nature's processes using the environment of space for scientific research, and commercial development, and to enrich life on Earth through people living and working in space" [9]. Please see Attachment 3 for CEFD Year 2 Report bibliographic footnotes.

During Year 2, CEFD CRT researchers utilized AERIAL travel grants to attend the 3rd Joint Meeting of the U.S. Sections of the Combustion Institute in Chicago, IL; the National NASA EPSCoR Annual Meeting in Washington, DC; and the Sixth International Microgravity Combustion Workshop at NASA's Glenn Research Center in Cleveland, OH.

Leverage of Additional Funding

During Year 2, CEFD CRT leaders and investigators applied for a variety of additional research funding. Specifically, the CEFD team has pursued appropriations from the U.S.

Department of Defense (DoD). CRT researchers submitted a proposal titled “Nanoscale-Based Biological and Chemical Detection Systems,” which was not funded. However, the current CEFD proposal, under review by the U.S. DoD, is titled “Advanced Materials for Mine Detection and Blast Mitigation” and would allocate an additional \$6 million to the CRT.

Since August 2001, over \$26,000 has been awarded to the CEFD CRT from the University of Nebraska – Lincoln (UNL) College of Engineering and Technology to support graduate work regarding “Portable PCR Amplifier with Novel Optical Detection Capabilities,” to support undergraduate combustion research, and to provide transition funding for bridge programs between grants. Additional UNL funding totaling \$260,000 has been obtained from Academic Program Priorities for 2002-2003 research involving simulation and computing engineering, and information technology and telecommunications. In total, the CEFD CRT has successfully secured \$286,000 in non-EPSCoR research funding and has applied for an additional \$6 million.

Technical Monitor Contact

Halfway through Year 2 and after strong encouragement from NASA Glenn Flight Research Center’s Dr. Vedha Nayagam (CEFD Technical Monitor), the CRT pursued the rapid development of their transient axisymmetric numerical code and related activities instead of completing Year 2 proposed components “Chemical Kinetic Models” and “Grid Adaptation.” The CEFD chose to accept Dr. Nayagam’s recommendations to schedule such objectives for future research beyond Year 3 after completing experiments involving radiation, low ambient temperatures, and methanol droplets.

Research and collaborative contacts are maintained between the CEFD CRT and Dr. David L. Urban and Dr. Vedha Nayagam of the National Center for Microgravity Research at GRC. In March 2003, Dr. Nayagam traveled to the University of Nebraska – Lincoln to meet with CEFD CRT members and to view their facilities. Current CEFD research and accomplishments were found by Dr. Nayagam to be “impressive.” The CEFD CRT has seen and is continuing to see much success in their research through various papers, presentations, and doctoral dissertations.

CEFD CRT 2001 – 2003 Cumulative Outcomes

- Gogos, G., & Zhang, H. (in review). Droplet evaporation within a zero gravity high pressure and high temperature environment. Part I. No relative motion. *International Journal of Heat and Mass Transfer*.
- Gogos, G., & Zhang, H. (in preparation). Droplet evaporation within a zero gravity high pressure and high temperature environment. Part II. Low Weber number relative motion. *International Journal of Heat and Mass Transfer*.
- Lu, K., Pope, D., & Gogos, G. (in preparation). Convective extinction of fuel droplets: Transient results. *Combustion and Flame*.
- Pope, D., & Gogos, G. (in review). Numerical simulation of n-Heptane droplet extinction due to forced convection. *Combustion and Flame*.

- Zhang, H., Shi, Y., & Gogos, G. (in preparation). Evaporation of a deformable fuel droplet under a forced convective environment. *International Journal of Heat and Mass Transfer*.
- Gogos, G., Soh, S., & Pope, D. (2003). Effects of gravity and ambient pressure on liquid fuel droplet evaporation. *International Journal of Heat and Mass Transfer*, 46, 283-296.
- Pope, D., Lu, K., & Gogos, G. (2003, June 3-6). *Combustion of moving droplets suspended within a convective environment: Transient numerical results*. Paper presented at the 7th International Workshop on Microgravity Combustion and Chemically Reacting Systems, Cleveland, OH.
- Pope, D.N., Lu, K., & Gogos, G. (2003, April 25). Combustion of moving droplets and of droplets suspended within a convective environment: Transient numerical results [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 31.
- Zhang, Z., Shi, Y., & Gogos, G. (2003, April 25). The evaporation and deformation of a moving fuel droplet in a high pressure combustion chamber, [Abstract]. *Proceedings of the 123rd Meeting of the Nebraska Academy of Sciences*, 31.
- Pope, D., Lu, K., & Gogos, G. (2003, March 16-19). Combustion of moving droplets suspended within a convective environment: Transient numerical results. *Proceedings of the Third Joint Meeting of the U.S. Sections of The Combustion Institute, Chicago, IL*.
- Gogos, G., Pope, D., Lu, K. (2003, March 16-18). *Validated numerical models for the convective extinction of fuel droplets*. Poster session presented at the annual meeting of the NASA Experimental Program to Stimulate Competitive Research, Washington, DC.
- Lu, K. (2002, December). *Numerical simulation of fuel droplet combustion under forced convection: Transient results*. Unpublished Master's Thesis, Department of Mechanical Engineering, University of Nebraska – Lincoln.
- Gogos, G. (2002, November). Sub- and super-critical evaporation and combustion of moving fuel droplets. Paper presented for the Department of Chemical Engineering, University of Nebraska – Lincoln, Lincoln, NE.
- Lu, K., Pope, D., & Gogos, G. (2002, April 26). *Numerical simulation of suspended and moving droplet combustion*. Paper presented at the 122nd Meeting of the Nebraska Academy of Sciences, Lincoln, NE.
- Zhang, H., Shi, Y., & Gogos, G. (2002, April 26). *Evaporation of a deformable fuel droplet under a forced convective environment*. Paper presented at the 122nd Meeting of the Nebraska Academy of Sciences, Lincoln, NE.
- Bowen, B., Gogos, G., et al. (2002, March). The Nebraska NASA EPSCoR Research Program in Propulsion Technology. *Paper presented at the National Space Grant Aerospace Technology Symposium 2002, White Sands, NM*.

Zhang, H., & Gogos, G. (2001, October 8-12). Droplet evaporation within a zero gravity high pressure and high temperature convective environment. *Proceedings of the International Conference on Power Engineering, Xi'an, China.*

Pope D. (2001, August). Numerical simulation of convective fuel droplet vaporization and combustion in a low pressure zero-gravity environment. Unpublished doctoral dissertation, University of Nebraska – Lincoln, Lincoln, NE.

**Aeronautics Education, Research, and Industry Alliance (AERIAL)
Year 3 Proposal**

I. Collaborative Research Teams (CRT)

A. Small Aircraft Transportation System (SATS): Scott Tarry, Principal Investigator

The SATS CRT will continue during Year 3 of its EPSCoR funding to build on the substantial foundation it has established in Years 1 and 2. The CRT will continue to be responsive to NASA Langley Research Center (LaRC) interests and the needs of the SATS program as it moves towards the technology and system demonstrations that are slated for 2005. Considerable work in systems analysis and assessment has been identified by NASA researchers through the SATS Transportation Systems Analysis and Assessment (TSAA) Working Group. CRT members Dr. Scott Tarry and Dr. Massoum Moussavi will continue to serve as members of the TSAA Working Group. Participation in the Working Group ensures that CRT research activities are consistent with the research goals and objectives of NASA and the National Consortium for Aviation Mobility, which is the public-private governing body charged by Congress with overseeing the development of the SATS concept. The Nebraska SATS CRT will also continue its collaborative work with the Research Triangle Institute, which heads the North Carolina / Upper Great Plains SATSLab, a consortium of public and private organizations with a special interest in applying the SATS concept to solving transportation problems in small and rural communities.

Policy and Implementation Analysis – S. Tarry, Principal Investigator and Lead Researcher

Scott Tarry will continue to serve as principal investigator for the Nebraska SATS CRT. The primary focus of his efforts during Year 3 of the EPSCoR supported SATS research program will be to guide CRT research so that it is consistent with the interests and objectives of NASA's SATS program. A notable part of this research is gaining a better understanding of the potential for business models based on SATS aircraft to successfully penetrate the market for transportation services, especially in rural areas. Building on previous research that compared SATS to Essential Air Service, Tarry will explore the role SATS might play in rural Nebraska if operated as an air taxi. Tarry will collaborate with researchers in North Carolina to replicate research on this question to see if the air transport needs of small rural communities in both states are similar. Key questions in this research include whether small communities would support such a system, which would likely entail giving up their interest in attracting or enhancing scheduled airline service. The impact of aviation noise on small communities will also be studied as CRT members continue analysis initiated in Year 2. Other issues involve the extent to which SATS will compete, successfully or otherwise, with automobile transportation, which dominates rural transportation at the present time. If SATS cannot be implemented in such a way that reduces costs and increases convenience of air travel in these communities so that air transport becomes an attractive alternative to automobile travel, the social and economic value of the SATS program will be limited. As a matter of public policy, this issue needs to be better understood.

Systems Assessment and Decision Support Analysis – M. Moussavi, Lead Researcher

Massoum Moussavi will continue building upon the Nebraska-SATS decision support system sub-models completed in Year 2. Moussavi will forge ahead with the development, testing, and integration of the complete systems engineering management tool that is the

centerpiece of his contribution to the CRT. It is anticipated that the effective use of Moussavi's model will aid the Nebraska State Aviation System Planners as they contemplate the improvements that need to be made to implement SATS in Nebraska. Again, as a matter of public policy, it is important that decision makers better understand the implications of moving toward a system of transportation based on advanced small aircraft. Moussavi continues to work with researchers at Virginia Tech, the Research Triangle Institute, and the other members of the NASA SATS Transportation Systems Analysis & Assessment Working Group (TSAA-WG) to integrate the Nebraska SATS Decision Support Model (DSM) into the regional and national SATS-DSM.

Moussavi will also continue his active participation in NASA SATS Transportation Systems Analysis & Assessment Working Group (TSAA-WG) teleconferences and contribute to the transportation system assessment and analysis work conducted at LaRC. Moussavi will maintain regular contact with Stuart Cooke, Jr., who leads that effort for NASA's SATS TSAA-WG team.

Financial Analysis – J. Bartle, Lead Researcher

John Bartle's plan for Year 3 is to complete his on-going work on the public finance issues surrounding the implementation of SATS. Bartle plans to submit his paper on airport infrastructure financing to a peer-reviewed journal. He also intends to submit proposals for at least two conference presentations on these issues. He will continue his research with his doctoral student, Rich Swayze, on sustainable transportation infrastructure financing with the goal of presenting a paper at a public administration conference. Presenting SATS related research in such venues is important because it gives SATS researchers the opportunity to engage scholars and policy makers who are not aware of SATS and who often have important perspectives that are not obvious to NASA researchers or the aviation community. Bartle's other project, co-authored with doctoral student Deniz Leuenberger, focuses on the impact of state tax limitations on the quality of transportation infrastructure.

Combined Efforts

Tarry, Moussavi, Bartle, and their graduate assistants are positioned to make real contributions to the assessment and analysis of SATS as NASA and its collaborators move closer to demonstrations of SATS technological capabilities. Making airplanes do what NASA's engineers think possible is only one piece of the SATS puzzle. A critical issue of the TSAA Working Group at NASA Langley is the development of an actual system of transportation might be developed around these aircraft. The Nebraska SATS CRT is poised through its work on business model development, decision support system modeling, and transportation finance to support the work of the TSAA Working Group and the broader SATS initiative.

Education and Outreach

The SATS CRT is committed to the education and training of new aeronautics researchers. Each of the projects described above depends upon the active involvement of graduate research assistants. These students are gaining substantive knowledge about SATS and aeronautics research, and just as equally important, they are gaining a valuable understanding of grant-funded research processes and practices, which will serve them well in their academic careers.

The CRT will continue its efforts in areas of outreach and education. CRT members are committed to presenting the results of their work from Year 1 and Year 2 and their ongoing research projects throughout Year 3. Tarry will work with the EPSCoR outreach coordinator to identify education and outreach opportunities for SATS. The CRT will also enhance its

collaboration with Native Institute for Managing Applications of Geospatial Extension (IMAGE) through the incorporation of SATS educational materials into the Family Aeronautical Science program.

Technical Monitor Contact and Collaborative Efforts

Dr. Tarry will continue to maintain consistent contact with the SATS CRT Technical Monitor, Dr. Bruce Holmes, at NASA LaRC. During April 2003, Tarry consulted with Bruce Holmes via teleconference in the preparation of both the Year 3 SATS proposal and Year 2 SATS report. Tarry will also maintain regular contact with and continue to develop the SATS CRT's relationship with LaRC through Jerry Hefner and Stuart Cooke, SATS CRT primary liaison. Dr. Kenneth Kriz, Assistant Professor in the UNO School of Public Administration, will join the SATS team in Year 3 to support research efforts and investigate possible parallels between the SATS concept and NASA's initiative on Spaceports. Additionally, Dr. Brent Bowen and doctoral student, Nanette Scarpellini-Metz, will continue to support the SATS CRT through their research involving SATS implementation policies and lessons learned from NASA's Advanced General Aviation Transport Experiments (AGATE).

B. Airborne Remote Sensing (ARS): Ram Narayanan, Principal Investigator

Due in part to his tremendous success as a NASA Nebraska EPSCoR researcher, the Airborne Remote Sensing (ARS) Principal Investigator (PI), Dr. Ram Narayanan, has been offered a faculty position with Pennsylvania State University. Therefore, ARS lead co-investigator, Dr. Donald Rundquist, will assume the position of project PI. Rundquist, Professor and Director of the University of Nebraska – Lincoln Center for Advanced Land Management Information Technologies (CALMIT), has been intricately involved in all ARS research and planning. During the third year of funding, the ARS CRT will complete the following research tasks:

Instrument Calibration and Validation (CalVal)

The current suite of operational instruments will be calibrated and validated. Calibration will be performed using standard surface targets (with known reflectance characteristics, such as concrete, tarpaulin, etc.) for optical and laser sensors, and active and passive corner reflectors for radar sensors. The calibration will be performed under different environmental conditions and the information will be saved for use while analyzing data. Validation procedure is required in order to make sure that the calibrated sensors provide meaningful data when used to measure the reflectance of known terrain and vegetation. Issues such as noise contamination and dynamic range limitations will be studied and methods to overcome these problems will be developed.

After the current suite of sensors has undergone CalVal procedures, ARS CRT members plan to perform comprehensive airborne data collection and data analysis. Data will be collected over crops and vegetation at the Mead Test Site. The ARS CRT will also make supporting concurrent ground measurements of vegetation biophysical properties and underlying soil parameters, such as leaf area index (LAI), crown cover, leaf water potential, soil moisture, etc. Additionally, forward and inverse models will be developed to analyze the data. The forward models will be developed first to predict the reflectance from a given set of crop and soil conditions. Using comprehensive simulation, the inversion models will be developed to obtain vegetation and soil properties using remote sensing data. The models will be refined using actual data acquired by our suite of sensors. While the ARS CRT had intended to perform this activity during Year 2, unforeseen developments delayed the deployment of the lidar and the SAR sensors, thus preventing this progress. The CRT will address this task during Year 3.

Creation of a Complete System for Collecting, Processing, and Disseminating Data

The overall goal for ARS CRT proposed work is create a complete system for: (a) collecting data for agricultural-vegetation communities at scales ranging from near-surface to satellite altitudes; (b) quickly processing those data to include archiving in a standard format, and including the necessary transformations (transparent to the user) from spectral radiance or reflectance into easily understood, recognizable agronomic units, measures, or parameters; and (c) providing useful, practical output products (e.g., maps showing plant condition, pigment content and composition, vegetation density, and potential yield) to other researchers, producers, and managers. In order to achieve the above goal, the following specific objectives have been identified, as related to both individual leaves and canopies of corn and soybeans:

1. Based on quantitative analyses of data collected by currently available hyperspectral radiometers operating in a field setting, ARS CRT members aim to: (a) estimate the status and condition of each crop at many times during the growing season; (b) estimate vegetation fraction (% cover); (c) estimate green leaf area index (LAI); (d) estimate pigment content and composition; (e) estimate leaf-water content; (f) develop a new quantitative technique for remote estimation of net CO₂ uptake; and (g) develop new vegetation indices for estimating plant-biophysical parameters and/or the energy flows and fluxes associated with crop canopies.
2. Based on quantitative analyses of data collected by the airborne "AISA" sensor (imaging spectrometer), ARS CRT members aim to: (a) estimate the status and condition of each crop at many times during the growing season; (b) estimate vegetation fraction (% cover); (c) estimate green leaf area index (LAI); (d) estimate pigment content and composition; (e) estimate leaf-water content; (f) develop a new quantitative technique for remote estimation of net CO₂ uptake and/or the energy flows and fluxes associated with crop canopies; (g) and develop new vegetation indices for estimating plant-biophysical parameters and/or the energy flows and fluxes associated with crop canopies.
3. Based upon quantitative analyses of data collected by the airborne MAPL sensor, ARS CRT members aim to: (a) estimate vegetation canopy height profile; (b) estimate canopy structure and sub-structure characteristics; (c) assess canopy stress conditions; (d) estimate above ground biomass; and (e) estimate vegetation characteristics such as basal area, mean stem diameter.

Boom Platform Remote Sensing Data Acquisition and Analysis

The SAR sensor is still at a more basic evolutionary stage in its development cycle. Consequently, ARS CRT members plan to perform comprehensive tests to evaluate the imaging capabilities of this sensor system atop a 10-m high van-mounted boom. These tests will be conducted primarily at the Mead test Site, and will involve bare soil as well as crop canopies. In parallel, this team will develop the necessary models for estimating various canopy characteristics from the SAR data. These include LAI, crop height, etc. Once the SAR system is fully tested under field conditions, the ARS CRT will develop the necessary mounting interface to integrate the system in the aircraft for airborne data acquisition. The major challenge will be the mounting of the antennas either under the wings or under the fuselage.

One of the crucial issues to produce an airborne SAR image with high resolution is the compensation of motion error. There are several sources that cause motion error, such as random turbulence in propagation media, non-constant flight path of the vehicle, and the vibration of the aircraft, etc. Specifically, uncompensated motion error between the true trajectory and the ideal trajectory introduces phase error during data acquisition, thereby

resulting in unfocused or blurry images. The effect of the phase error will be examined by applying the phase error function formulation, first to the SAR data obtained from Sandia National Laboratory, and then to the data collected by our SAR sensor. Further development of autofocus techniques will be continued.

Continued Development and Testing of New Sensors

ARS CRT members plan to work aggressively to continue the development and testing of the laser fluorescence sensor. The ARS Year 2 analytical and experimental study has provided the necessary information on the major issues involved in the development of this unique sensor system. It has already been established by ARS research that the time dependent fluorescence spectra are superior to the long integration signal for the purposes of estimating the degree of stress in the plant. Preliminary designs are underway and the CRT expects to complete the development and initial testing of this sensor during Year 3. Additionally, the CRT will transition into an applications focus during Years 4 and 5. This will be accomplished with NASA Center guidance and technical monitor collaboration.

Error Characterization

This will be a significant initiative of the ARS CRT during Year 3, and this includes plans to make a detailed study and analysis of various error sources, some unique to airborne remote sensing. This will assist in understanding the impact of error sources on the retrieval of biophysical and soil properties using inversion algorithms. These include instrument noise, aircraft pointing errors, and calibration uncertainty, among others.

Technical Monitor Contact

Research and collaborative contacts will continue to be maintained between the ARS CRT and Dr. K. Jon Ranson at the Biospheric Science Processing department at Goddard Space Center and the Commercial Remote Sensing Program at Stennis Space Center. Jon Ranson was consulted in the preparation of the Year 3 ARS proposal and has received a copy of the Year 2 ARS report.

C. Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD): George Gogos, Principal Investigator

The major goal of the CEFD research is to develop a comprehensive validated numerical model for droplet combustion in a forced convection environment. Advances in convective droplet combustion (including convective extinction) are of great interest for practical combustion devices and address one of the long-term goals of NASA's Human Exploration and Development of Space (HEDS) Enterprise microgravity combustion program. The development of the proposed validated numerical model will enhance Dr. Nayagam's well-defined flight definition experiment currently sponsored by the NASA Microgravity Combustion Science Program. Recognizing this, Principal Investigator, Dr. George Gogos, held discussions with Dr. Nayagam regarding further developing of the CEFD model. Additional features to be researched and to be incorporated in the CEFD numerical model were prioritized to enhance collaboration. Following the aforementioned discussions, the following aspects need to be researched and incorporated in the transient axisymmetric model in the order presented below.

Radiation

Gas phase radiation measurements of axisymmetric flame configurations for n-heptane and methanol droplets burning in a slow convective flow field were recently obtained by Hicks, Kaib, Easton, Nayagam, and Williams [1]. Results show that for the sizes of droplets considered

(0.8 mm to 3.4 mm) radiation losses are important. Furthermore, radiation losses are expected to be more important for the even larger droplets that will be considered in the flight experiment.

The formulation of the problem will ignore soot. The literature has shown [2-4] that in spherically symmetric droplet combustion soot particles form a "spherical shell" between the droplet surface and the flame zone. The shell's location is defined by the balance between two forces acting on the soot particles (namely, the radially inward thermophoretic force and the radially outward force exerted by the evaporation-induced flow field). This shell acts as a radiation shield and may have a significant effect on the rate of droplet burning in spherically symmetric droplet combustion [5]. In the presence of convection, however, both the temperature field and the flow field are two-dimensional (actually axisymmetric). As a result, the two forces acting on precursors to soot particles are no longer radial. In addition, the two forces do not in general act in opposite directions. As a result, these precursors are not expected to move toward an equilibrium position. The soot "shell" under such conditions "is like a particle trajectory along which soot aggregates move in response to forces acting on them" [6]. This has been clearly shown in the literature [7]. The convective motion carries the soot precursors and particles to the flame region in the downstream direction where oxidation takes place before the particles can grow to appreciable size. Randolph and Law [7] have shown that even a weak convection that has almost no influence on fuel oxidation (as evidenced by the near sphericity of the flame) transports continuously the soot precursors to the rear region. There is a luminous flame zone, characteristic of the presence of soot radiation, only towards the rear of the droplet. The rest of the flame is blue--even for the case of phenyldodecane, which is quite sooty. Consequently, it is hypothesized that the effect of soot on convective droplet combustion is negligible. This hypothesis can actually be tested by comparing experimental data with model predictions over a wide range of strength of the convective field. Predictions should deviate from the experimental data increasingly as spherically symmetric conditions are approached.

Gas phase radiation will be included in the model following Marchese, Dryer, and Nayagam [8]. Thermal radiation losses in the gas phase result entirely from nonluminous emission associated with carbon monoxide, carbon dioxide, and water. The effect of gas phase radiation can be handled with a small increase in computational requirements [8]. Alternatively, the radiation treatments employed by Tien and coworkers [9,10] where carbon dioxide and water vapor were considered emitting and absorbing radiation in discrete bands (nongray gases) will also be considered.

Convective Droplet Combustion at Low Ambient Temperatures

The transient modeling of the ignition of a liquid fuel droplet presents a major challenge. In general, two types of ignition processes are utilized in droplet combustion experiments: (1) the droplet is introduced into an environment at a sufficiently high temperature to cause the fuel-vapor/oxidizer mixture to autoignite, and (2) the droplet is introduced into a low temperature environment and an external source, such as a spark or hot wire, is used to ignite the fuel-vapor/oxidizer mixture. The current unsteady axisymmetric code is able to model the first case (hot-ignition). Adapting the code to model the second ignition process (cold-ignition) presents several problems. In the cold-ignition process, the droplet evaporates in the cold environment for some time prior to the application of the ignition source. The ignition source is typically applied at the upstream side of the droplet, which causes a local rise in temperature with a corresponding decrease in the local density. The gas near the ignition source expands, opposing both the incoming freestream and the flow from the droplet surface. This expansion causes rapid changes in the flow field near the fuel droplet. The rapid changes in the flow and temperature

around the droplet during the entire ignition process (until the flame surrounds the droplet) present a significant challenge to the accurate and efficient modeling of the cold-ignition process. It should be noted here that Marchese et al. [8] modeled the cold-ignition process under spherically symmetric conditions which removes the requirement of solving the momentum equations. It is the coupling of the pressure and velocity in the axisymmetric code that can lead to stability problems.

Methanol Droplets

One of the complications that arises in droplet combustion experiments that use n-alkanes is the formation of soot. To avoid this complication, the Associated Experiment, in addition to n-heptane droplets, will study the combustion of methanol droplets. During the combustion of methanol droplets, water vapor condenses at the droplet surface, dissolves into the liquid droplet, and may later revaporize. The CEFD numerical model will be modified to include a multicomponent liquid droplet and to account for the solubility of gaseous species into the liquid droplet.

Discussion of Future Activities Beyond Year 3

a. Grid Adaptation

In general, adaptive schemes attempt to couple the location of grid points to the physics of the problem resulting in a concentration of grid points in regions where the dependent variable changes rapidly. The goal of utilizing an adaptive grid system is to obtain accurate numerical solutions with a minimum number of grid points. The decrease in the number of grid points reduces memory usage and cpu time, which makes solution of more complex problems possible. This will be a requirement for the present two-dimensional problem due to the large number of dependent variables introduced when using semi-detailed or detailed chemical kinetics.

Incorporation of an adaptive grid into a numerical model of droplet combustion that uses complex chemistry presents several challenges. The large number of dependent variables in the problem makes it difficult to develop appropriate criteria for concentrating grid points. For example, the fluid mechanics and heat transfer form different regions of small scale in droplet combustion. A dense grid is required near the droplet surface to adequately determine velocity and temperature gradients, and the droplet surface regresses due to evaporation of the fuel. Regions adjacent to and within the flame front must have sufficient detail to determine the location of the flame and to model the rapid chemical reactions. For large "droplets" (porous spheres), when an envelope flame is present at high velocities the flame is concentrated in a thin region that is close to the droplet surface along the upstream side of the droplet and that extends many diameters on the downstream side of the droplet. The presence of different combustion regimes (envelope flame, transition flame, wake flame, and pure vaporization) and the transition between these regimes corresponds to large changes in the location of high temperature regions. The rapid changes in temperature will necessitate the use of an adaptive time-step to limit the grid point motion and capture the fundamental physics during "highly transient" periods (such as convective extinction) of the droplet lifetime.

The CEFD CRT will include an adaptive grid system and adaptive time-step in their numerical model of droplet combustion. This team will start with adaptation in the radial-direction only (one dimension) with an implementation similar to that of Dwyer (which was based on the velocity gradient and the first and second derivatives of temperature with respect to the radial coordinate). A two-sided hyperbolic tangent stretching function will be used to give a fixed, non-uniform grid distribution in the polar-direction, with grid points concentrated near the axis of symmetry to capture details in the wake of the droplet and at the forward stagnation-point

where convective extinction occurs. This initial grid adaptation scheme requires minimal computational effort and is relatively easy to implement. The adaptive time-step will be implemented by using absolute limits on both the movement of grid points during a given time-step (i.e. grid point velocity) and the change of temperature or velocity during a given time-step. Extension of this relatively simple adaptive scheme to two-dimensional grid adaptation will be investigated. A completely general two-dimensional scheme (such as elliptic grid generation with control functions based on all of the dependent variables present in the current problem and their spatial derivatives) would be computationally prohibitive at best and may even be impossible at the present time.

b. Chemical Kinetics Models

Finite-rate chemical kinetics models for large hydrocarbon combustion range from global kinetics using a one-step overall chemical reaction to detailed mechanisms with hundreds of reactions and chemical species. For numerical models, the trade-off for an increased level of detail in the chemical kinetics is an increase in cpu time and computer memory requirements. Each additional species included in the model requires the solution of an additional conservation of species equation at each node as well as storage for the species mass fraction at each nodal point. An increase in the number of chemical reactions requires additional computations, which in turn results in an increase in cpu time. As a result, axisymmetric numerical models for large hydrocarbon combustion have been limited to the use of global kinetics.

The CEFD CRT will incorporate semi-detailed kinetics in a two-dimensional model of combustion of a moving droplet in a low-pressure environment. Semi-detailed mechanisms for large hydrocarbons have been used in one-dimensional numerical models for droplet combustion. Use of these mechanisms in a two-dimensional model will require adaptive grid and parallel computing techniques to obtain accurate solutions within a reasonable time while minimizing memory requirements. Several mechanisms already available for use in the proposed model will allow for an appropriate model or models to be selected based on validation with experimental results. Please see Attachment 4 for the CEFD Year 3 Proposal bibliographic footnotes.

Technical Monitor Contact

Research and collaborative contacts will continue to be maintained between the CEFD CRT and Dr. David L. Urban and CEFD Technical Monitor, Dr. Vedha Nayagam, both of the National Center for Microgravity Research at John Glenn Research Center. In March 2003, Dr. Nayagam traveled to the University of Nebraska – Lincoln to meet with CEFD CRT members and to view their facilities. Nayagam offered consultation regarding preparation of the CEFD Year 2 Report and Year 3 Proposal.

II. Core Funding for Seed Research

The emerging areas of research are an outgrowth of required seed research funding. The following items have emerged from Year 2 allocations and will grow in Year 3. It is envisioned that these innovative areas of seed research will be incorporated within current CRT objectives and that they will grow to be funded through other federal grant programs as a result of EPSCoR and Space Grant research initiatives. Seed funding is primarily used to develop new research areas, establish contacts at NASA centers, and fund graduate and undergraduate researchers in similar research endeavors. Additionally, such funding will assist in continuing the efforts of the Nebraska Geospatial Extension Program and developing Native IMAGE at Little Priest Tribal

College (LPTC), the main focal points of AERIAL seed research. The process to select new seed research areas continues to be competitive.

A. Geospatial Extension Program Research

The Nebraska Geospatial Extension Program (NEGEP) fulfills NASA's goal of the placement of a Geospatial Extension Specialist in every state. Through the Earth Science Enterprise, a partnership was created between NASA, USDA, and Space/Sea Grant to develop the program. Nebraska is currently one of only eleven states to develop a Geospatial Extension Program. Karisa Vlasek, Geospatial Extension and Research Specialist, will continue to serve in this role for 2003-2004. The NEGEP will strive to be innovative as it serves the citizens of Nebraska in the area of geospatial technologies. The following activities will be pursued by the Nebraska Geospatial Extension Program during 2003:

Further Development of Native IMAGE (Institute for Managing Applications in Geospatial Extension)

The NEGEP will continue to support and develop Native IMAGE (Institute for Managing Applications in Geospatial Extension). Collaborative activities include training workshops in geospatial technologies, Winnebago/Little Priest Tribal College (LPTC) library enhancements, student assistantship opportunities, community development, outreach projects, and the establishment of a geospatial data center at LPTC.

Establishment of Geospatial Data Centers

A component of the NEGEP is the development and placement of geospatial data centers across Nebraska. The first data center will be placed within Native IMAGE. Students from LPTC as well as Winnebago community members will have access to the workstation. The data center will consist of hardware and geospatial software which will allow users to access technologies such as GIS and remote sensing. The development and placement of other data centers at community and tribal colleges across Nebraska will be implemented.

CRT Collaborations

Collaborations between the Airborne Remote Sensing (ARS) CRT and the NEGEP will continue to be fostered. The ARS platform provides an opportunity for data collection using a true color and color infrared camera, ASD (spectral radiometer), and the AISA (airborne imaging spectrometer) sensor. Data collection took place using the color infrared camera over the Santee Sioux and Winnebago Reservation in 2002. More missions are planned for reservation data collection.

This extension program will also develop a stronger partnership with the Small Aircraft Transportation System (SATS) CRT. Several areas of the SATS project have been identified for possible collaboration. The SATS team has been working on the capability to engage in noise modeling. GIS is a powerful tool and can be used to overlay, store, and analyze noise contours. By partnering together, the SATS CRT can utilize many of the geospatial tools available including GIS and remote sensing.

GeoSTAC (GeoSpatial Training and Analysis Cooperative)

A relationship will be further fostered with the Idaho Space Grant Consortium & EPSCoR Program. GeoSTAC, a product of Idaho Space Grant, was developed to offer on-line, non-credit tutorials in geospatial technologies. The primary goals of GeoSTAC include workforce training, providing a link between university, government, and private industry with geospatial technologies, promoting the end use of NASA and other remote sensing platforms,

and providing tools for decision-making. On-line training will be a key component of the Nebraska Geospatial Workforce Development Initiative and Native IMAGE.

Lewis & Clark Project

Collaborations will be developed between NEGEP and the Bicentennial commemoration of the Lewis and Clark Expedition. Numerous activities will take place across the state of Nebraska and geospatial technologies can enhance the understanding of the expedition. Native IMAGE will give Native Americans the opportunity to describe how the Lewis and Clark Expedition impacted the course of their history.

Outreach Collaborations

A successful relationship has been established with the University of Nebraska at Omaha's College of Education. Past projects include the duplication and dissemination of the DataSlate CD-ROM and the International Space Station EarthKAM Project. The NEGEP will maintain support for DataSlate dissemination and participate in the further development of CD content. These activities are part of the NEGEP's goal to engage the K-16 community in geospatial education. New collaborations for K-16 education will be developed for 2003-2004.

University of Nebraska Cooperative Extension

Further partnerships will be established with the University of Nebraska Cooperative Extension. Geospatial workshops and seminars will be offered to Cooperative Extension Agents, who can in turn, train potential users such as farmers and ranchers.

Opportunities for Presentations and Publications

Numerous opportunities are being developed for members of the NEGEP to present and publish outcomes. A publication submission to ESRI's Native Geography magazine will showcase the AERIAL initiative, Native IMAGE. A poster proposal will also be submitted to the American Society for Public Administration for presentation. Other opportunities include the ESRI's Annual User and Educational Conference, Intertribal GIS Meeting, Western Regional Space Grant Meeting, Space Grant Director's Meeting, Nebraska Academy of Sciences, Association of American Geographer's Annual Meeting, and the Annual Meeting of the American Society of Photogrammetry and Remote Sensing.

Midwest ArcUsers Group Conference

The 2003 Midwest ArcUsers Meeting will occur in Omaha, NE for the first time since the group was founded. The conference will provide a forum for users of GIS software to gather and share their experiences. Plans are being made for paper and poster presentations, a NEGEP display booth, and participation in short courses. Additionally, students, faculty, and community members involved in Native IMAGE will be strongly encouraged to present and attend.

B. Native Institute for Managing Applications of Geospatial Extension

In 2003, Dr. Henry (Hank) R. Lehrer will continue to lead the Native Institute for Managing Applications in Geospatial Extension (IMAGE). Rhonda Pitt will continue as the Little Priest Tribal College (LPTC) liaison through the U.S. Department of Agriculture Extension, while Jan Bingen, LPTC Computer Science Department Director, will increase her involvement to include education and public outreach responsibilities. Other LPTC faculty, staff, and consultant trainers will continue to offer their support for completion of various Native IMAGE objectives, which are outlined below.

Training and Faculty Development

With assistance from the Nebraska Geospatial Extension Program, Native IMAGE will continue to provide training on Geographic Information Systems (GIS) and Airborne Remote

Sensing (ARS) components and offer research opportunities in the other geospatial fields. Personnel of the Institute will organize regional geospatial workshops and coordinate the enhancement of LPTC's traditional and on-line courses. Such workshops will allow LPTC, CALMIT, and UNO to share collected data with the Winnebago community through specialized articles, posters, presentations, and geospatial training modules. Additionally, Native IMAGE will provide continued faculty development in geospatial subjects for faculty members at LPTC and WPS. Workshop opportunities will be available during the Summer of 2003 at the USGS EROS Data Center and UNL's CALMIT. These workshops will expose faculty to in-depth training in GIS, remotes sensing, and GPS.

Opportunities for Students

Native IMAGE will continue to offer assistant opportunities to LPTC students. Two student assistantships have already commenced at the Institute. In addition, a geosciences club is currently being developed and will be open to any interested students in the Winnebago area. The club will focus on educational activities, field trips, guest speakers, and exposure to educational and career opportunities in the geosciences.

Development of Library Materials

In partnership with the NEGEP, Native IMAGE will continue the procurement of geospatial holdings for the expansion of the LPTC/Winnebago Library. With the placement of a geospatial lab at LPTC, these materials will be a valuable resource.

Creating Community Partnerships

The geospatial information that Native IMAGE will assist LPTC and the Winnebago community in collecting will be used to locate and identify the location of significant tribal cultural resources and historical sites. Specifically, David Smith, the Winnebago Tribal Historian and Archivist, will work with Native IMAGE personnel to locate and catalogue former tribal burial sites.

Data Dissemination

In 2003, Native IMAGE personnel will begin the archiving process for local GIS and ARS data collection and provide documentation for dissemination to other colleges and universities. Additionally, Native IMAGE will support several outreach endeavors that will expose the community to new geospatial technologies. This includes the incorporation of additional library holdings to the geospatial collection at the LPTC library.

Fostering Collaborations

Of the 35 current tribal colleges, few are engaging in a geospatial emphasis. Native IMAGE will highlight the Winnebago community's involvement in the geosciences and also foster collaboration between the community, LPTC, and faculty participants from other tribal colleges including Nebraska Indian Community College, Salish Kootenai College, and Sinte Gleska University, among others. Native IMAGE personnel will also actively support the establishment of Native View, a data archiving effort housed at the Sinte Gleska College in Rosebud, SD. The Institute will also seek to establish outreach relationships to other tribes and tribal colleges.

Geospatial Station

The development of an innovative geospatial laboratory is underway. Through this lab, the Winnebago community will have access to a variety of GIS and ARS software, hardware, and equipment. This geospatial station will be housed in the new library that will be opened in fall 2003 at LPTC.

Establishment of a Native IMAGE Advisory Board

Native IMAGE personnel will establish an advisory committee which will consist of individuals from academics (Creighton, UNO, UNL-CALMIT, Wayne State), industry (ESRI), government (tribal council, EROS Data Center), and other tribal colleges (Sinte Gleska, Salish Kootenai, Diné).

Nebraska Native American Education Outreach

Development of strong linkages and a viable partnership with the Winnebago Public Schools (WPS) will be a high priority in 2003. Of particular emphasis will be the expansion of the highly successful Family Aeronautical Science (FAS) program, a component of the AERIAL Families United in the Discover of Science (FUN) component. Key FUN activities highlight basic aerodynamics, flight control systems, wing design, and basic flight. The paradigm of FUN is that students and teachers cover several appropriate parts of the unit at school, then students complete more of the unit after school hours with their family, during "FAS Nights." These nights include an evening meal combined with science demonstrations by Nebraska Indian Community College (NICC), Little Priest Tribal College (LPTC), and University of Nebraska at Omaha faculty; directed group activities; visits by NASA researchers/educators; and fellowship. The underlying goal is the continued improvement of mathematics and science skills among these Native American youngsters through involvement of the family unit.

The planned expansion to FAS through FUN will integrate geospatial activities into curriculum that focuses on junior high school level students, particularly those students in grades 7 and 8. This new curriculum will include topics such as GPS, GIS, and Remote Sensing. LPTC and Native IMAGE, in cooperation with the WPS, will provide this development.

Native IMAGE will continue to support the participating FAS teacher at each elementary and high school with small faculty stipends. The Institute will also provide the supplies for FAS nights as well as meal expenses. Native IMAGE personnel will also develop a series of geospatial family-related activities similar to the FAS program to be offered within the Winnebago community. It is anticipated that such a series will be exported to Walthill and Santee in future years.

Native IMAGE will provide a sufficient number of software applications for integration within all Winnebago public school computers based on the ESRI Arc series and includes ArcExplorer and ArcGIS. Many of these packages are available free of charge from ESRI. Native IMAGE will serve in a facilitator capacity for the implementation of this component.

III. Support for NASA Collaboration Building

A. Travel Grants

Through AERIAL, grants will continue to be available for travel to NASA research and field centers in support of specific collaboration-building activities. AERIAL will continue to give priority to faculty members who are not members of the three collaborative research teams but who wish to pursue new NASA collaborations. Based on NASA Nebraska EPSCoR's past experience, several types of travel grants are envisioned: (a) day visits; (b) short-term (three to four days) visits; (c) one- to two-week visits; and (d) 10-week faculty internships. Travel grants will be awarded to faculty members to travel to other academic institutions for possible NASA collaboration. AERIAL will also award travel grants for faculty researchers to attend academic conferences, symposia, and/or technical meetings that offer opportunities for the development of new networks and linkages with NASA-affiliated researchers as well as joint presentations and the strengthening of existing collaborations. Current travel grants have begun to foster

collaborative relationships at the following three NASA Centers: (1) Johnson Space Center in Houston, Texas; (2) Dryden Flight Research Center in Edwards, California; and (3) Ames Research Center in Mountain View, California.

B. Technical Advisory Committee

The Technical Advisory Committee (TAC) will continue to convene semi-annually (November 2003 and April 2004) to provide advice and recommendations to the AERIAL leadership team. Members will be informed of progress through periodic written reports and oral presentations from Dr. Bowen and the research cluster principal investigators, evaluation results and reports, and the AERIAL on-line newsletter. The TAC will also participate in AERIAL's strategic planning process through in-depth interviews, board meetings, and review of draft documents; its members will act as liaisons between AERIAL and the organizations they represent. For a complete listing of current TAC Members, please see Attachment 2. The TAC members are in positions of considerable authority within their respective organizations. The committee will continue to be composed of personnel from Nebraska industry, Nebraska government, Nebraska Space Grant, Nebraska EPSCoR, and other influential members of the aviation community and academia. They bring to the board ample resources and knowledge that advance the goals of AERIAL. The configuration of the TAC is designed to ensure that productive relationships between AERIAL and Nebraska's state capability programs are cultivated and sustained.

C. Coordination with Nebraska Space Grant Consortium (NSGC)

As director of the NSGC, Dr. Bowen will ensure that all written and oral AERIAL progress reports are offered to members of the NSGC advisory board through meetings or individual consultation. Additionally, through an external review, NSGC board members will provide comments and recommendations regarding AERIAL activities, progress, and modifications. This will be completed during the annual AERIAL performance review.

Dr. Bowen's dual role as NSGC director and AERIAL director continues to ensure effective and efficient coordination and communication between the two organizations. For example, proposed AERIAL initiatives regarding geospatial extension, Native American outreach, and workforce development complement the objectives of the NSGC.

D. Coordination with State EPSCoR Committee and Other Stakeholder Organizations

The AERIAL leadership team recognizes the importance of coordinating its efforts with the Nebraska EPSCoR office. Therefore, in Year 2, Project Director Bowen will continue to provide regular AERIAL progress reports to the Nebraska EPSCoR Committee. Additionally, members of the EPSCoR committee will be asked to participate in annual external reviews of the research clusters' performance and outcomes. Coordination with the Nebraska EPSCoR office is also maintained through the AERIAL Communications Specialist, who contributes AERIAL updates to the state EPSCoR newsletters, brochures, and presentation displays. AERIAL will coordinate its activities with those of Nebraska EPSCoR and other federal agencies, including the DOD, NSF, FAA, and Department of Transportation. All organizations affiliated with AERIAL, including federal agencies, will again be actively encouraged to utilize the NASA Nebraska AERIAL website, as well as e-mail distribution lists, regarding AERIAL announcements.

E. Electronic Resources

The NASA Nebraska EPSCoR/AERIAL management team will continue to utilize extensive electronic resources – including a joint NASA Nebraska EPSCoR/AERIAL website, CD-ROM technology, and distance education – to bolster AERIAL's research and outreach endeavors, further the goals of AERIAL, and extend its impact throughout the state and nation. The existing NASA Nebraska Space Grant Consortium (NSGC) & EPSCoR website (<http://nasa.unomaha.edu>) will continue to be expanded in the implementation of AERIAL. The website continues to include grant announcements and applications, current research projects and listings of published research, program descriptions, program staff, and upcoming events. The website currently provides links to: (a) NASA, NASA EPSCoR, NASA Enterprises and Centers, and the National Space Grant and Fellowship programs; (b) numerous aerospace/aeronautics websites of interest to researchers, educators, students; and (c) other NASA EPSCoR and Space Grant-funded sites.

The Nebraska Space Grant Consortium will continue to be involved in e-learning technologies through the enhancement and development of the Aviation Institute's on-line degree program, CD-ROM production, support for the Aviation Institute Flight Lab, and faculty/staff productivity support. The Aviation Institute has been involved in distance education for the past five years. This component supports the University of Nebraska at Omaha's only undergraduate and graduate on-line programs. A collaborative effort will continue to be maintained with the University of Nebraska at Kearney to provide on-line courses that students need for graduation.

The NSGC has also developed CD-ROMs for classroom enhancement material and document delivery. CD-ROMs have also been produced and distributed for the Journal of Air Transportation, Small Aircraft Transportation System, Airline Quality Rating, Aviation Institute Marketing, NASA Preparation Grant Final Reports, and several course packets. Finally, NSGC continues to provide funding for the management of a computer lab for students within its college. This lab houses 20 computers and three staff members.

F. Technology Transfer/Industrial Relations

NASA Nebraska EPSCoR will be committed to the identification and development of technology transfer opportunities. The technology transfer phase of the research project transforms the designs, ideas, research, and innovations of Nebraska researchers to the development phase, where the project is nurtured by identified technology transfer experts (eventually leading to utilization applications). The team collaborates with many organizations and individuals to stimulate technology transfer. The team has identified an individual at each NASA Center whose expertise will be utilized. Mr. Al Wenstrand, Director of the Nebraska Department of Economic Development will continue to serve on the AERIAL TAC, as will Mr. Stephen Frayser, President of the University of Nebraska Technology Park. Additional industrial relations are being cultivated through the developing student internship program created through a partnership between NASA Nebraska EPSCoR and the University of Nebraska Technology Park.

NASA Nebraska EPSCoR is currently working with the Nebraska extension service. Year 3 provides an opportunity to cultivate this collaboration through partnerships at the Center for Advanced Land Management Information Technologies (CALMIT), specifically to work with NASA's commercial program, which is housed there.

Additionally, each of the three AERIAL CRTs will continue their technology transfer plans. Private industry collaborators will continue to be invited to participate in the advisory board meetings, where they can provide guidance and input for the program's research activities.

G. Public Outreach Education and Extension

Outreach education and extension will continue to play a fundamental role in the AERIAL EPSCoR grant through the dissemination of information and enhancement of educational value. Outreach education and extension focus on three areas: (a) the use of the World Wide Web to post information; (b) collaboration through regional and national conferences in aeronautics and education; and (c) the enhancement of distance education capabilities and technologies. These cornerstone projects will continue to be associated with AERIAL's outreach education and extension efforts. Each component – based on the research of the CRTs – encompasses collaboration with researchers and NASA personnel, while working with extension agencies, disseminating information, and partnering with Native IMAGE. The Research Implementation and Communications Specialist will continue to support the educational outreach activities of the NSGC & EPSCoR programs through project management and external communications. The liaison function of this new position will continue to promote and strengthen the relationship between the NSGC & EPSCoR office and the community. The Geospatial Extension and Research Specialist will work closely with Native IMAGE personnel to incorporate geospatial data into the Family Aeronautical Science program and continue to seek new opportunities for geospatial outreach.

IV. Student Support/Workforce Development

The likelihood that Nebraska will sustain long-term growth in aeronautics research and industry depends upon the ongoing development of a well-trained aerospace workforce. Nebraska will continue enhancing its internal capacity both to motivate its youth to pursue education and careers in aerospace-related fields and eventually to encourage them to seek related employment in the state. While the NSGC continues to be the primary source of aerospace-related outreach activities for the state, AERIAL will continue to include the provision of CRT-based outreach activities as well as fellowships, assistantships, and internships for undergraduate and graduate students. Additionally, the Geospatial Extension and Implementation teams will continue to support the workforce development components of the program. Positions created within the SATS CRTs to aid in workforce development will also continue their mission.

V. Quality Assurance and Program Evaluation Planning

The NASA Nebraska EPSCoR management team will continue to use its data management system in the implementation of its NASA-funded projects. Intensive self- and external evaluations will continue to occur for all AERIAL components. Consistent with NASA EPSCoR guidelines, the primary components of the evaluation will be: (a) research success of each AERIAL collaborative research team; (b) examples of technology transfer occurring due to AERIAL-sponsored research; (c) evidence of evolving collaboration among AERIAL staff and researchers and researchers from NASA Field Centers and/or the Strategic Enterprise Offices at NASA Headquarters; (d) evidence of new, collaborative aerospace research activities occurring within the state; and (e) indications of how AERIAL activities have addressed state priorities in technology, aerospace/aviation, and economic development. All program evaluations and

reports will be reviewed by Dr. Bowen and the Nebraska Space Grant Consortium Board. Additionally, program research and outreach initiatives will be examined at the planned biannual AERIAL TAC meetings. Recommendations for ensuing years will be recorded, and modifications will be made as necessary. Dr. Bowen will continue to submit annual reports to NASA University Affairs for evaluation.

The principal investigators from each CRT will continue to provide evidence of scientific accomplishment and demonstrate communication of those accomplishments through: (a) scientific publications, presentations at academic conferences, and symposia; (b) increased collaboration with NASA and other researchers in the state; (c) contributions to industry; (d) patents; (e) proposal submissions to other funding sources; and (f) improvements in infrastructure. Evaluations will focus on these outcomes and are considered prior to future awards. Junior faculty recipients of fellowships and seed and travel grants will submit reports detailing scientific accomplishment. Recipients of seed grants submit similar semi-annual progress reports.

AERIAL's success will be measured by indicators of long-term systemic growth in Nebraska's aerospace research capacity and industrial development that will be evident long after NASA funding ceases. Progress toward this end will be measured in several ways during and after the funding period of AERIAL: (a) in the increased level of aerospace research activities throughout the state (as evidenced through increased levels of refereed publications, invited presentations, development of patents, etc); (b) in the increase in non-NASA forms of aerospace research funding by senior and junior faculty members; (c) by the development of new (and expansion of current) aerospace-related industry that leads to overall growth in the state's economy; (d) in a net increase of Nebraskan students enrolling in aerospace-related fields of study at Nebraska's colleges and universities as well as an increase in the number of Nebraskan college graduates accepting faculty and researcher positions within the state; and (e) in the increased level of NASA-driven collaborative research throughout the state.

VI. Funds Distribution and Financial Management Systems and Controls.

As with the research clusters, all fund distributions will be made on a competitive basis. Calls for proposals will continue to be issued statewide through a variety of channels, and proposals will be accepted from faculty members at any Nebraska institution. Selection will be made by ad-hoc committees drawn from the AERIAL TAC, Nebraska EPSCoR Board, and the Nebraska Space Grant Consortium.

During Year 3, the Aviation Institute at University of Nebraska at Omaha will continue to house and act as the managing structure for AERIAL, and thus maintain overall control and responsibility for its implementation. All participating AERIAL institutions will continue to form subcontractual agreements with UNO, which will use standard grants and contracts and financial accounting procedures that are subject to internal as well as external audits. Dr. Bowen will be responsible for day-to-day fiscal management of AERIAL, while UNO's Office of Grants Accounting will prepare regular fiscal reports. Dr. Bowen will review and approve appropriate project expenditures, subject to further approvals and reviews as specified in university procedures.

VII. Schedule of Joint Meetings with NASA Personnel

A key component of Nebraska's strategy in initiating, broadening, and sustaining its relationships with NASA personnel will continue to be its emphasis on face-to-face, on-site

meetings with personnel from NASA Field Centers and Strategic Enterprise Offices at NASA Headquarters. The NASA Nebraska/AERIAL director (Dr. Bowen) as well as other AERIAL staff will continue this strategy by meeting at least once each year with NASA EPSCoR personnel at NASA Headquarters and University Affairs Officers at collaborating NASA Field Centers.

Key personnel from the three collaborative research teams will continue to make at least one visit per year to collaborating Field Centers. Additional meetings will be scheduled, when possible, at academic conferences or symposia when Nebraska and their respective NASA collaborators are in attendance. NASA researchers will be invited to make site visits to Nebraska to meet with AERIAL administrators and/or CRT faculty researchers and students.

VIII. Program Administration

The administration of AERIAL during Year 3 will continue to focus on the achievement of the program's goals and objectives, including ongoing identification of collaborative research opportunities with NASA personnel, the support of AERIAL's research endeavors, the building of Nebraska's aerospace infrastructure facility technology transfer, the implementation of outreach activities, and increased inclusion of Native Americans in all program activities. The AERIAL strategic planning process will be ongoing as well, and will be reviewed at the annual meeting of the NASA Nebraska Space Grant & EPSCoR TAC.

Attachment 1

NASA Center Collaborative Action			
<u>AERIAL Personnel</u>	<u>Center Contact</u>	<u>Date of Contact</u>	<u>Place of Contact</u>
<i>Ames Research Center (ARC)</i>			
Mary Fink	Doug O'Handley	SG Dir Meeting – October 2002	Puerto Rico
Michaela Schaaf	Doug O'Handley	SG Dir Meeting – October 2002	Puerto Rico
Massoum Moussavi	Bonnie Samuelson	Teacher Programs – July 2002	ARC
Massoum Moussavi	Doug O'Handley	Astrobiology Academy – July 2002	ARC
Massoum Moussavi	Davis Lamb	Astrobiology Academy – July 2002	ARC
Massoum Moussavi	Emily Schaller	Astrobiology Academy – July 2002	ARC
Massoum Moussavi	Michael Landis	July 2002	ARC
Massoum Moussavi	David Peterson	July 2002	ARC
Massoum Moussavi	Donald James	July 2002	ARC
Massoum Moussavi	Brenda Collins	July 2002	ARC
Massoum Moussavi	Tom Clausen	July 2002	ARC
Massoum Moussavi	Susanne Ashby	July 2002	ARC
Massoum Moussavi	Deborah Bazar	July 2002	ARC
Massoum Moussavi	Michael Freeman	July 2002	ARC
Henry Lehrer	Bonnie Samuelson	April 2003	ARC
Henry Lehrer	Tom Clausen	April 2003	ARC
Henry Lehrer	Liza Alderette	April 2003	ARC
Henry Lehrer	Doug O'Handley	April 2003	ARC
Henry Lehrer	Joe Tanner	May 2002	ARC
Henry Lehrer	Michael Landis	July 2002	ARC
Henry Lehrer	David Peterson	April 2003	ARC
Henry Lehrer	Donald James	April 2003	ARC
<i>Dryden Flight Research Center (DFRC)</i>			
Michaela Schaaf	Susan Miller	SG Dir Meeting – October 2002	Puerto Rico
Mary Fink	M. Rodon-Naveira	SG Dir Meeting – October 2002	Puerto Rico
Karisa Vlasek	Susan Miller	SG Dir Meeting – October 2002	Puerto Rico
Henry Lehrer	James Lucero	May 2003	DFRC
<i>Goddard Space Flight Center (GSFC)</i>			
Michaela Schaaf	Margarita Cardona	SG Dir Meeting – October 2002	Puerto Rico
Karisa Vlasek	Blanche Meeson	SG Dir Meeting – October 2002	Puerto Rico
Henry Lehrer	Dave Rosage	March 2003	GSFC
Henry Lehrer	Richard Fahey	March 2003	GSFC
Ram Narayanan	K. Jon Ranson	Teleconference – March 2003	GSFC
<i>Jet Propulsion Laboratory (JPL)</i>			
Michaela Schaaf	Linda Rodgers	SG Dir Meeting – October 2002	Puerto Rico
Karisa Vlasek	Linda Rodgers	SG Dir Meeting – October 2002	Puerto Rico
Michaela Schaaf	Linda Rodgers	Western Region SG – September 2002	Big Sky, MT
Brent Bowen	Linda Rodgers	Teleconference – March 2003	
Henry Lehrer	Nancy Leon	April 2002	JPL
Henry Lehrer	Pat Liggett	July 2002	JPL
<i>Kennedy Space Center (KSC)</i>			
Michaela Schaaf	Gregg Buckingham	SG Dir Meeting – October 2002	Puerto Rico
Brent Bowen	Gregg Buckingham	Western Region SG – September 2002	Big Sky, MT

Attachment 1 (continued)

Kennedy Space Center (KSC)

Michaela Schaaf	Gregg Buckingham	Western Region SG – September 2002	Big Sky, MT
Henry Lehrer	Gregg Buckingham	Western Region SG – September 2002	Big Sky, MT
Brent Bowen	L. Michael Freeman	NASA EPSCoR Meeting – Mar. 2003	Washington, DC
Brent Bowen	L. Michael Freeman	Western Region SG – September 2002	Big Sky, MT
Henry Lehrer	L. Michael Freeman	Western Region SG – September 2002	Big Sky, MT
Shane Farritor	Mike Sklar	American Institute of Aeronautics & Astronautics – April 2003	KSC
Shane Farritor	Thomas Lippitt	American Institute of Aeronautics & Astronautics – April 2003	KSC
Brent Bowen	Rita Willconn	February 2003	KSC
Brent Bowen	Greg Buckingham	February 2003	KSC
Brent Bowen	Renee Ponik	February 2003	KSC
Brent Bowen	Jim Aliberti	February 2003	KSC
Brent Bowen	Chuck Griffin	February 2003	KSC
Brent Bowen	Danny Culbertson	February 2003	KSC
Richard Box	Rita Willcoxon	February 2003	KSC
Richard Box	Phil Weber	February 2003	KSC
Richard Box	Gregg Buckingham	February 2003	KSC
Richard Box	Jim Aliberti	February 2003	KSC
Richard Box	Chuck Griffin	February 2003	KSC
Richard Box	Danny Culbertson	February 2003	KSC

Stennis Space Center (SSC)

Brent Bowen	Ramona Travis	NASA EPSCoR Meeting – Mar. 2003	Washington, DC
Karisa Vlasek	Ramona Travis	NASA EPSCoR Meeting – Mar. 2003	Washington, DC
Karisa Vlasek	Marco Gerodina	ESRI Training – December 2002	San Antonio, TX
Don Rundquist	Bruce Davis	March 2003	Denver, CO

Langley Research Center (LaRC)

Brent Bowen	Roger Hathaway	NASA EPSCoR Meeting – Mar. 2003	Washington, DC
Scott Tarry	Stuart Cooke	August 2002	LaRC
Scott Tarry	Bruce Holmes	August 2002	LaRC
Scott Tarry	Jerry Hefner	August 2002	LaRC
Scott Tarry	Elizabeth Ward	August 2002	LaRC
Scott Tarry	Jerry Hefner	TSAAWG – October 2003	LaRC
Scott Tarry	Stuart Cooke	TSAAWG – October 2003	LaRC
Scott Tarry	Bruce Holmes	March 2002	LaRC
Massoum Moussavi	Jerry Hefner	TSAAWG – August 2002	LaRC
Massoum Moussavi	Bruce Holmes	TSAAWG – August 2002	LaRC
Massoum Moussavi	Stuart Cooke	TSAAWG – August 2002	LaRC
Massoum Moussavi	Pete McHugh	August 2002	LaRC
Massoum Moussavi	Elizabeth Ward	August 2002	LaRC
Massoum Moussavi	Roger Hathaway	August 2002	LaRC
Massoum Moussavi	Bryan Campbell	August 2002	LaRC

Johnson Space Center (JSC)

Brent Bowen	Bonnie Dunbar	Western Region SG – September 2002	Big Sky, MT
Brent Bowen	Jennifer Blume	December 2002	JSC
Brent Bowen	Donald Henninger	December 2002	JSC
Brent Bowen	Karnlesh Lulla	December 2002	JSC
Brent Bowen	Brian Peacock	December 2002	JSC

Attachment 1 (continued)

Johnson Space Center (JSC)

Brent Bowen	Lakshmi Putcha	December 2002	JSC
Brent Bowen	Donn Sickorez	December 2002	JSC
Michaela Schaaf	Bonnie Dunbar	Western Region SG – September 2002	Big Sky, MT
Karisa Vlasek	Kamlesh Lulla	ESRI Training – December 2002	San Antonio, TX

Glenn Flight Research Center (GRC)

Scott Tarry	Bob Corrigan	TSAAWG – October 2003	GRC
George Gogos	Vehda Nayagam	March 2003	Lincoln, NE

Marshall Space Flight Center (MSFC)

Henry Lehrer	Dawn Mercer	January 2002	MSFC
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NASA Headquarters

Don Rundquist	Ed Sheffner	March 2003	Washington, DC
		Office of Earth Science Applications Division	
Henry Lehrer	John Barsa	March 2003	Washington, DC

Attachment 2

2001 – 2003 TAC Members

<u>Member Name</u>	<u>Title and Affiliation</u>
Ms. Shelly Avery	Campus Coordinator, Nebraska Indian Community College
Dr. Royce Ballinger	Director, Nebraska EPSCoR
Ms. Diane Bartels	Vice President, Air Force Association
Dr. Otto Bauer	Professor (ret), University of Nebraska at Omaha
Dr. John Block	Professor, Little Priest Tribal College
Mr. Ed Brogie	Executive Director, Nebraska Academy of Sciences
Dr. Samuel L. Brown	Professor, University of Nebraska at Omaha, School of Public Administration
Mrs. Celika Caldwell	Interim Director of Technology Transfer, University of Nebraska Technology Park
Dr. Larry Carstenson	Chair, Department of Management, University of Nebraska – Kearney
Ms. Christi Churchill	Strategic Air and Space Museum
Dr. Ann Downes	President, Little Priest Tribal College
Mr. James Dugan	Campus Coordinator, Hastings College
Dr. Samy Elias	Associate Dean for Research, Nebraska Research Initiative
Dr. John Farr	Associate Vice Chancellor, University of Nebraska at Omaha
Dr. Lynne Farr	Campus Coordinator, University of Nebraska Medical Center
Dr. Shane Farritor	Campus Coordinator, University of Nebraska – Lincoln
Dr. E. Terence Foster	Campus Coordinator, University of Nebraska at Omaha & Lincoln
Mr. Stephen Frayser	President, University of Nebraska Technology Park
Dr. George Gogos	Associate Professor, University of Nebraska – Lincoln
Dr. Neal Grandgenett	Associate Professor, University of Nebraska at Omaha
Ms. Lisa Haile	Coordinator, Services for Students with disABILITIES
Ms. Wanda Henke	Teacher, Santee Schools
Dr. Derek Hodgson	Vice Chancellor Academic Affairs, University of Nebraska at Omaha
Ms. Diane Hofer	Airport Project Manager, Nebraska Department of Aeronautics
Mr. James Joyce	Chair, Technical Division, Western Nebraska Community College
Mr. Dave Kipling	Associate, Great Plains Girl Scouts
Lt. Col. Charles Lane	99 th Pursuit Squadron, Civil Air Patrol
Mr. Tommie Lee	Safety Engineer, 3M
Dr. Henry Lehrer	Professor (ret), University of Nebraska at Omaha
Brig. Gen. Roger Lempke	Nebraska National Guard
Mr. Virgil Likness	Superintendent, Winnebago Public Schools
Ms. Kathleen Lodl	Nebraska 4-H Youth Development, University of Nebraska – Lincoln
Dr. Denise Maybank	Director, University of Nebraska at Omaha Office of Multicultural Affairs
Dr. Ram Narayanan	Professor, University of Nebraska – Lincoln
Dr. Jay Noren	Executive Vice President and Provost, University of Nebraska – Lincoln
Mr. Kent Penney	Director, Nebraska Department of Aeronautics
Dr. Louis Pol	Associate Dean, University of Nebraska at Omaha College of Business
Ms. Barb Rebrovich	Campus Coordinator, Metropolitan Community College
Dr. Betty Redleaf	Campus Coordinator, Little Priest Tribal College
Dr. B. J. Reed	Dean, College of Public Affairs and Community Service
Mr. Robert Rose	President, Tuskegee Airmen, Inc,
Mr. Jack Ruff	Director, Existing Business Assistance Division, NE Dept. of Economic Development
Dr. Donald Rundquist	Director, Center for Advanced Land Management Information Technologies
Dr. John Schalles	Professor and Chair of Biology, Creighton University
Mr. Dave Schrader	Director of Aviation, Grace University
Dr. Sean Semler	Campus Coordinator, College of Saint Mary
Dr. Russ Smith	Chair, College of Public Affairs and Research University of Nebraska at Omaha
Mr. Don Smithey	Executive Director, Omaha Airport Authority
Dr. Scott Tarry	Professor, UNO Aviation Institute
Dr. Lois Veath	Professor of Physics, Chadron State College
Mr. Al Wendstrand	Director, Nebraska Department of Economic Development
Ms. Sara Woods	Assistant Dean, College of Public Affairs and Community Service

Attachment 2 (continued)

TAC ex officio members

Dr. Brent Bowen	Distinguished Professor, University of Nebraska at Omaha Aviation Institute
Mrs. Mary Fink	Coordinator, NASA Nebraska Space Grant & EPSCoR
Mrs. Jocelyn Nickerson	Research Implementation & Communications Specialist, NASA Nebraska Space Grant & EPSCoR
Mrs. Michaela Schaaf	Assistant Director, NASA Nebraska Space Grant & EPSCoR
Mrs. Amy Tegeder	Administrative Assistant, NASA Nebraska Space Grant & EPSCoR
Mrs. Karisa Vlasek	Geospatial Extension and Research Specialist, NASA Nebraska Space Grant & EPSCoR
Mr. Scott Vlasek	Manager of Technology-Based Educational Systems, UNO Aviation Institute

TAC meeting dates

April 2004	124 th Nebraska Academy of Sciences, Nebraska Wesleyan University, Lincoln, NE
November 21, 2003	Alumni Center, University of Nebraska at Omaha, Omaha, NE
April 25, 2003	123 rd Nebraska Academy of Sciences, Nebraska Wesleyan University, Lincoln, NE
December 3, 2002	University of Nebraska Technology Park, Lincoln, NE
April 26, 2002	122 nd Nebraska Academy of Sciences, Nebraska Wesleyan University, Lincoln, NE
December 7, 2001	Marina Inn, South Sioux City, NE

Attachment 3

Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD)

References for Year 2 Report

1. Lu, K., *M.S. thesis*, Mechanical Engineering, University of Nebraska-Lincoln, 2002.
2. Pope, D. N., *Ph.D. thesis*, Mechanical Engineering, University of Nebraska-Lincoln, 2001.
3. Pope, D.N., Lu, K. and Gogos, G. "Combustion of Moving Droplets and of Droplets Suspended within a Convective Environment: Transient Numerical Results", Third Joint Meeting of the U.S. Sections of The Combustion Institute, Chicago, IL, March 16-19, 2003.
4. Gogos, G., Pope, D.N. and Lu, K. "Validated Numerical Models for the Convective Extinction of Fuel Droplets", NASA EPSCoR Annual Conference, Arlington, Virginia, March 16-18, 2003
5. Gogos, G. and Pope, D.N. "Combustion of Moving Droplets and of Droplets Suspended within a Convective Environment: Transient Numerical Results", 7th International Workshop on Microgravity Combustion and Chemically Reacting Systems, Cleveland, OH, June 3-6, 2003.
6. Zhang, Z., Shi, Y. and Gogos, G. "The Evaporation and Deformation of a Moving Fuel Droplet in a High Pressure Combustion Chamber, Annual Meeting of the Aeronautics and Space Science Division, Nebraska Academy of Sciences, Lincoln, NE, April 25, 2003.
7. Pope, D.N., Lu, K. and Gogos, G. "Combustion of Moving Droplets and of Droplets Suspended within a Convective Environment: Transient Numerical Results", Annual Meeting of the Aeronautics and Space Science Division, Nebraska Academy of Sciences, Lincoln, NE, April 25, 2003.
8. Pope, D.N. and Gogos, G. "Numerical Simulation of Fuel Droplet Extinction during Forced Convection", International Conference on Power Engineering, Nov. 9-13, 2003.
9. NASA Experimental Program to Stimulate Competitive Research (2003). Research Compendium. Office of Human Resources and Education, NASA Headquarters, Code FE, Washington, DC: Author.

Attachment 4

Validated Numerical Models for the Convective Extinction of Fuel Droplets (CEFD)

References for Year 3 Proposal

1. Hicks, M.C., Kaib, N., Easton, J., Nayagam, V. and Williams, F.A., Third Joint Meeting of the U.S. Sections of the Combustion Institute, Chicago, IL, March 16-19, 2003.
2. S. Okajima, and S. Kumagai, Proceedings of the Combustion Institute, 15:401-407 (1975).
3. B.D. Shaw, F.L. Dryer, F.A. Williams, and J.B. Haggard, Acta Astronaut., 17:1195-120 (1988).
4. G.S. Jackson, C.T. Avedisian and J.C. Yang, Proc. R. Soc. Lond., A435:359-369 (1991).
5. C.T. Avedisian, Physical and Chemical Aspects in Combustion, pp. 135-160, Gordon and Breach (1997).
6. C.T. Avedisian, personal communication.
7. A.L. Randolph and C.K. Law, Combust. Flame, 64:267-284 (1986).
8. A.J. Marchese, F.L. Dryer and V. Nayagam, Combust. Flame, 116:432-459 (1999).
9. Bedir, H. and Tien, J.S., Twenty-Seventh Symposium (International) on Combustion/The combustion Institute, 2821-2828, 1998.
10. Rhatigan, J.L., Bedir, H. and Tien, J.S., Combustion and Flame, 112:231-241, 1998.